TRANSACTIONS AND PROCEEDINGS

OF THE

BOTANICAL SOCIETY OF EDINBURGH.

VOLUME XXX.

PART IV.

SESSION 1930–31.

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PROCEEDINGS
OF THE
BOTANICAL SOCIETY OF EDINBURGH

SESSION XCV

OCTOBER 16, 1930.

J. Rutherford Hill, Ph.C., President, in the Chair.

The following Office-Bearers were elected for Session 1930–1931 :—

PRESIDENT.

J. Rutherford Hill, Ph.C.

VICE-PRESIDENTS.

W. Edgar Evans, B.Sc.
Symington Grieve, Esq.
Professor R. A. Robertson, M.A., B.Sc.
John Sutherland, C.B.E., LL.D.

COUNCILLORS.

Mrs. N. L. Alcock, F.L.S.
Miss Lucy Boyd, B.Sc.
Wm. C. Callender, Esq.
Robert Craig Cowan, Esq.
E. Wyllie Fenton, M.A., B.Sc.
James W. Gregor, Ph.D., F.L.S.
Sir Everard im Thurn, K.C.M.G., K.B.E.
J. M. Murray, B.Sc.
Alex. Nelson, B.Sc., Ph.D.
J. A. Terras, B.Sc.

Honorary Secretary—R. J. D. Graham, M.A., D.Sc.
Foreign Secretary—Professor W. Wright Smith, M.A.
Treasurer—Andrew Mason, Esq.
Assistant-Secretary—J. T. Johnstone, M.A., B.Sc.
Artist—R. M. Adam, Esq.
Auditor—Wm. C. Callender, Esq.

Mr. Robert Murray, Dr. J. M. Cowan, and Mr. Wm. B. Steel were elected Ordinary Fellows.

The President announced the death of Mr. E. M. Holmes, who had been a Fellow since 1878.

Mr. R. E. Cooper read a paper, Notes on the Flora of Bhutan, which he illustrated with numerous lantern slides.

Mr. R. M. Adam communicated the Reports of the Scottish Alpine Botanical Club for 1928 and 1929 (see pp. 246, 250).

NOVEMBER 20, 1930.

J. Rutherford Hill, Ph.C., President, in the Chair.

The President announced the death of Mr. E. H. Wilson, an Honorary Foreign Member, and of Mr. James Currie, LL.D., an Ordinary Fellow.

Mr. Symington Grieve read a paper, More about the Floating Power of Seaweed, and also a paper on Researches in connection with the Decomposition of Seaweed and the Generation of Gas.

The following plants in flower were shown from the Royal Botanic Garden: *Acampe papillosa* Lindl.; *Angraecum caespitosum* Rolfe; *Aphelandra nitens* Hook. f.; *Callicarpa purpurea* Juss.; *Cephalangraecum glomeratum* Schlechter; *Cestrum Smithii* Hort.; *Coelogyne miniata* Lindl.; *Columnea gloriosa* Sprague var. *superba*; *Cymbidium giganteum* Wall.; *Dendrobium amplum* Lindl.; *Erica decipiens* Spreng. f.; *Jasminum rex* Dunn; *Pleione maculata* Lindl. et Paxt.; *Pleurothallus Scapha* Reichb. f.; *Ponera juncifolia* Lindl.; *Rhipidoglossum rutilum* Schlechter; *Rhodostachys bicolor* Benth. et Hook. f.; *Rondeletia odorata* Jacq.; *Salvia uliginosa* Benth., and *Sonerila argentea* Hort.

DECEMBER 18, 1930.

J. Rutherford Hill, Ph.C., President, in the Chair.

The Treasurer, Mr. Andrew Mason, submitted the following Statement of Accounts for Session 1929–1930:—

INCOME.

Annual Subscriptions for 1929–1930	£58	0	0
Do. Arrears	4	15	0
Transfer from Life Members' Fund	21	4	0
Transactions sold	12	0	6
Interest on Funds Invested and in Bank	13	11	9
Subscriptions to Publications Fund	7	5	0
Income from Botanical Society Trust Fund	17	8	10
	£134	5	1

EXPENDITURE.

Printing *Transactions* for Session 1928–29	£98	7	1
Printing and Postage of Notices for Meetings, etc.	20	14	6
Rooms for Meetings and Tea	7	7	9
Stationery, Postages, Advertising, etc.	5	16	2
Fire Insurance on Books, etc.	0	5	0
Income Tax on Untaxed Interest (4 years)	10	4	0
Honorarium to Treasurer	3	3	0
	£145	17	6
Excess of Expenditure	£11	12	5

STATE OF FUNDS.

Life Members' Fund.

Balance of Fund at close of Session 1928–29	£242	11	0
Add—Life composition received	10	10	0
	£253	1	0
Deduct—Transferred to Income	21	4	0
Balance as at close of Session	£231	17	0

Ordinary Fund.

Balance of Fund at close of Session 1928–1929	£150	2	10			
Deduct—Decrease during Session 1929–1930	11	12	5			
Balance as at close of Session, subject to expense of printing *Transactions*				138	10	5
Total Funds				£370	7	5
Being:—£200 5% War Stock, 1929–1947, at cost	£194	18	3			
Sum in Current Account with Union Bank of Scotland, Ltd.	15	14	2			
Sum in Deposit Receipt with do.	160	0	0			
Due by Treasurer	3	0	0			
	£373	12	5			
Less—Subscription received in advance	3	5	0			
As above				£370	7	5

Note.—Subscriptions in arrear, considered recoverable, 1928–29, £1, 15s.; 1929–30, £3.

EDINBURGH, 28th *November* 1930.—I hereby certify that I have audited the Accounts of the Treasurer of the Botanical Society of Edinburgh for Session 1929–1930, and have found them correct. I have also checked the foregoing Abstract, and find it correct. I have seen the securities for the invested funds and have found them in order.

W. C. CALLENDER, *Auditor.*

BOTANICAL SOCIETY TRUST FUND.

INCOME.

Interest on Funds invested	£17 8 10

EXPENDITURE.

To Publications Fund	£17 8 10

EDINBURGH, 1*st December* 1930.—I certify that I have examined the books and vouchers of the Edinburgh Botanical Society Trust Fund, and certify the same to be correct.

ALEX. ARNOTT.

Professor WILLIAM HENRY LANG was elected an Honorary British Fellow.

Miss A. W. DICKSON, Mr. CHARLES MUIRHEAD, Mr. H. C. TORBOCK, and Mr. JAMES H. WHYTE were elected Ordinary Fellows.

Mr. J. BOWDEN was elected an Ordinary Member.

Mr. C. E. FOISTER read a paper on the White Tip Disease of Leek, which he illustrated with lantern slides (see p. 257).

Mr. HAROLD F. COMBER read a paper on Plant Collecting in the Andes, which he illustrated with a large number of lantern slides of scenery and of individual plants.

FEBRUARY 19, 1931.

Professor W. WRIGHT SMITH, M.A., in the Chair.

Mrs. HAROLD COWIE, Mr. G. L. ALLARDYCE, Major-General GRANVILLE EGERTON, and Mr. T. A. S. FORTUNE were elected Ordinary Fellows.

Mr. JAMES A. MACDONALD was elected an Ordinary Member.

The CHAIRMAN announced the death of Professor OSTENFELD, an Hon. Foreign Fellow, of Capt. WM. STEWART of Shambellie, an Ordinary Fellow, and of Professor BEIJERINCK, who had been a Corresponding Member since 1905.

Miss CADMAN read a paper on the Life History of *Didymium nigripes*, which she illustrated with lantern slides.

Mrs. Mary J. F. Gregor read a paper on Heterothallism in *Ceratostomella*, which she illustrated with lantern slides.

Miss Herring exhibited specimens of the common diseases of apples.

The following plants in flower were shown from the Royal Botanic Garden: *Aster reflexus* Linn.; *Clematis cirrhosa* Linn.; *C. Forrestii* W. W. Sm.; *Coelogyne Parishii* Hook.; *Cyclamen libanoticum* Hildebr.; *Dendrobium aemulum* R. Br., *D. delicatum* Bailey, *D. gracilicaule* F. Muell., *D. subclausum* Rolfe; *Lilium roseum* Wall. var. *Thomsonianum*; *Loropetalum chinense* Oliver; *Lycaste Lucianii* ×; *Odontoglossum Rossii* Lindl.; *Oncidium splendidum* A. Rich.; *Prostanthera rotundifolia* R. Br.; *Skimmia Veitchii* Carr.; *Soldanella alpina* Willd. var. *alba*; and *Whitfieldia lateritia* Hook.

MARCH 19, 1931.

J. Rutherford Hill, Ph.C., President, in the Chair.

The President announced the death of Dr. Lennox, who had been a non-Resident Fellow since 1878.

Mr. R. M. Adam gave an account of the visit of the Scottish Alpine Botanical Club to Braemar and Glenshee, which he illustrated with a large number of lantern slides.

The following plants in flower were shown from the Royal Botanic Garden: *Agapetes Moorei* Hemsl., *A. buxifolia* Nutt.; *Camellia reticulata* Lindl.; *Crassula columnaris* Linn. f.; *Dendrobium Beckleri* F. Muell., *D. linguiforme* Sw., *D. speciosum* Sm., *D. tetragonum* A. Cunn.; *Eria obesa* Lindl.; *Greenovia diplocycla* Bolle; *Kitchingia campanulata* Baker; *Moricandia sonchifolia* Hook.; *Pentapterygium serpens* Klotzsch; *Rhododendron arboreum* Sm. var. *album*, *Rh. barbatum*, G. Don, *Rh. calophytum* Franch., *Rh. irroratum* Franch., *Rh. lutescens* Franch., *Rh. spinuliferum*, *Franch.* and *Vanda Bensoni* Batem.

APRIL 23, 1931.

Professor W. Wright Smith, M.A., in the Chair.

The Chairman announced the death of Professor W. A. McIntosh of St. Andrews (see p. 251).

Dr. Graham read a paper by himself and Mr. Stewart on Leaf Propagation of *Acalypha*, *Gasteria*, and *Dioscorea*, and illustrated it with a number of specimens (see p. 282).

Mr. J. T. Johnstone exhibited a series of coloured pictures of flowers published by Dr. Thornton, *c.* 1795–1808.

MAY 21, 1931.

Symington Grieve, Esq., Vice-President, in the Chair.

Mr. H. A. Latham was elected an Ordinary Fellow.

Mr. H. B. Gilliland read a paper on the Occurrence of Cortical Bundles in the Stem of *Ruscus aculeatus* Linn., which he illustrated with diagrams and microscopic slides (see p. 284).

Mr. M. Y. Orr exhibited a number of specimens showing fasciation and other abnormalities of form and structure.

JUNE 18, 1931.

J. Rutherford Hill, Ph.C., President, in the Chair.

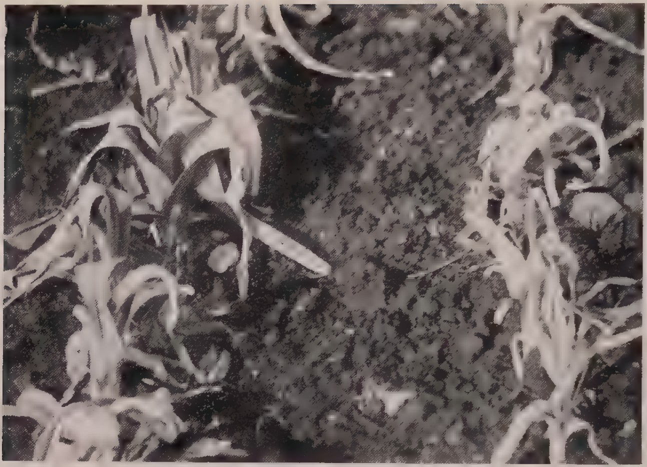
Miss Lucy Boyd read a paper on Evolution in the Monocotyledonous Seedling: a new Interpretation of the Morphology of the Grass Embryo, which she illustrated with diagrams (see p. 286).

A series of papers—Notes on Salt-Marsh Plants, were read: (1) *Glaux maritima* Linn., by Miss Margaret A. Moir (see p. 304); (2) *Plantago maritima* Linn., by Mr. David F.

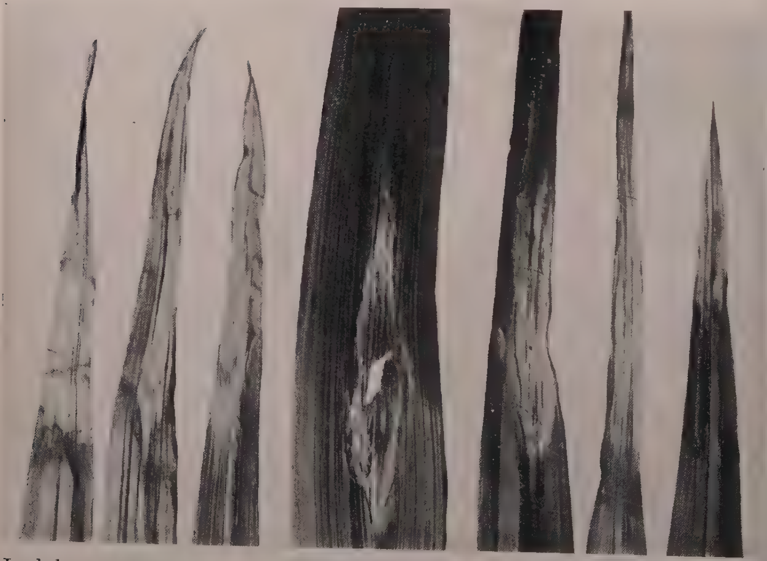
Stewart (see p. 313); (3) *Triglochin maritimum* Linn., by Mr. James Park (see p. 320). Each of these papers was illustrated with diagrams.

Dr. E. Philip Smith read a preliminary paper on Stomatal Movement by Miss M. I. Jolly and herself.

Miss J. J. Stevenson exhibited two Weaver Birds' Nests from Sungei Patani, Kedah.



" White Tip " Leeks showing collapse, loss of colour, and the large space between rows.



Leek leaves affected with " White Tip " Disease. The large central leaf shows a water-logged area, and to its right is a marginal infection.

(Reproduced by courtesy of the Gardeners' Chronicle.)

C. E. Foister.

TRANSACTIONS

OF THE

BOTANICAL SOCIETY OF EDINBURGH

SESSION XCV

The White Tip Disease of Leeks and its Causal Fungus, Phytophthora Porri n. sp.

By C. E. Foister, B.A., Ph.D. (With Pl. XVIII.)

(Read 18th December 1930.)

A disease of Leeks, called by the growers "White Tip," has become of considerable importance in the last five or so years. It has probably been in existence for a long time, but has only recently become of serious importance. In September 1928 trials were initiated in Midlothian for the control of Downy Mildew of Leeks (*Peronospora Schleideni*), and what was supposed to be this disease was already appearing in plots adjoining the trial plots. White Tip symptoms were supposed to be an unusual manifestation of the Downy Mildew, although not at all like the usual symptoms of the disease. On examination this proved a wrong supposition, and eventually the cause of the White Tip symptoms was identified as a species of *Phytophthora*. There are no records of the approximate date when this disease was first noted. Growers have a varied experience of it, and some report that it has appeared in the last ten years, while others say that it was known in the previous generation, if not two generations ago. It has apparently been lying dormant for years, and has become epidemic owing to the influence of unknown factors. It has spread considerably in the three years that the writer has had it under observation, and is present generally in the Lothians down to the Borders. It has been noticed in England before, but was associated with Downy Mildew; it was only after a warning note was published (8) that the Leeks were examined and the same *Phytophthora* found. It is recorded (14) as severe at Cheltenham and round Bristol, and is probably present elsewhere. It has not been found yet out of Great Britain.

PATHOLOGY.

The symptoms in sequence are the yellowing and dying of the tips of leaves, followed by this area turning white. This white area may measure half an inch to six inches long, and while most bend backwards, becoming disfigured by saprophytic fungi, some turn crisp, curl, and do not bend. Sometimes the apical attack is replaced by a marginal infection at any place from near the tip to about half-way down the leaf. As this area dies, the tissues contract and the leaf is twisted. Usually associated with these symptoms is a water-logged area developed half-way down or at the base of the leaf. The causal fungus can be found in the infected areas before chlorosis sets in, being abundant if there are moist conditions at the time (see Pl. XVIII).

Large plants when severely attacked rot away and break at the soil level when pulled. When all the leaves are affected, either their sale is impossible or the market value is reduced to prices which do not pay for their cartage. Young, badly diseased plants remain stunted, and pulling is not worth the labour. Slightly infected plants, while they may be bought once, will not be bought a second time by the public owing to the fact that the plants wilt overnight, whereas healthy plants will remain firm for many days.

The cause of the disease is a *Phytophthora*, and is readily found in the yellow, water-logged areas, less easily in the white areas. It is present as a large non-septate mycelium which is both inter- and intra-cellular. Oogonia with both paragynous and amphigynous antheridia are produced in abundance, while oospores are formed as the leaf dries up. The amphigynous antheridium is the dominant type in the tissues. When the leaf is very wet or kept under very humid conditions conidia are produced also, but they have never been seen on the living host under field conditions. *Botrytis allii* Munn, *Pleospora Herbarum* (Pers.) Rab., *Fusarium* sp., yeasts and bacteria are the saprophytes which follow the *Phytophthora* infection and cause the rot which ensues. The mycelium can be traced from the leaves into the stem and even into the base of the plant, but it is very scarce in the base.

The isolation and artificial growth in culture of the parasite was long and troublesome. Cultures made direct from the host, even after external disinfection, were not successful. The methods employed either failed to kill the accompanying saprophytes or killed the parasite. Minute portions of the fungus, even though pure, died in culture tubes, possibly because they had not sufficient food in them to prevent death before the absorption of nutriment from the medium. Oospores and sporangia isolated from the host also failed to grow. Eventually the parasite was induced to grow as luxuriantly as possible in nutrient solutions. The yeasts and bacteria were washed away each day by placing the pieces of tissue in a funnel covered with muslin and running water passed through for several hours ; the tissue was replaced in the nutrient and the process repeated several days. By this time the saprophytes, which hitherto had prevented the parasite from growing, were eliminated and the parasite had grown into a fair-sized mass of hyphae, which was cut off from the tissue and transferred to a Quaker Oat Agar culture, in which it grew and subcultures were subsequently taken.

Infection experiments to test the pathogenicity of the fungus isolated have been tried. Soil was sterilised and planted with young seedling Leeks; pieces of cultures were placed against some in the soil and between sets of pairs. In no case has infection resulted. In infection of leaves, the experiment at the time had to be run so that the uninoculated plants were within a short distance of the infected ones, and it is probable that the small percentage of uninoculated ones that became diseased was due to aerial distribution of the parasite. Slightly wounded and inoculated plants gave 77 per cent. infection, unwounded and inoculated 29 per cent., and uninoculated 18 per cent. In the experiments it was found that the fungus produced its conidia profusely on the surface of the soil, and in many instances aerial infection of plants has been traced to this infected soil, and it is presumed that the conidia so produced are picked up by currents of air and carried to the aerial portions of Leeks. These conidia are smaller than those produced in water cultures, and this fact confirms their action as conidia—wind blown—rather than as sporangia. The fungus has been grown artificially in sterilised soil in petri dishes, and there it has formed surface conidia and deeper down abundant oospores. In the field, the action of many growers who plough in severely diseased crops places in the soil countless numbers of oospores. Even though the mycelium of the parasite is killed by unfavourable conditions—and this is almost certain —the oospores probably survive and germinate with the right conditions. The subsequent mycelium lives for a time saprophytically, then produces surface conidia which are blown on to the leaves of the host. It is probable that not every plant will be infected in such a manner, but a secondary epidemic may spread from these plants by conidia produced on the leaves. They cannot be numerous, as they have not yet been seen in the field by the writer. It is possible that sporadically, according to temperatures, they will be produced for a very short time in moderate numbers, and this will account for the occasional observations that spread may occur in the direction of wind. It is probable that conidia are produced externally on the leaves—they are produced internally when the leaves are moist—when the air is very humid, such as in mists. The theory of wind distribution was supported by the facts in 1928, when, during the critical period and in a certain area, the direction of the prevailing wind was in the north-east, and the disease rapidly spread to the south-west. In 1930 spread was negligible, and odd-shaped diseased areas were dotted about indiscriminately, usually coinciding with the ploughing in of previously diseased Leeks. The weather was certainly different to that of 1928, and may be held responsible for the absence of spread from each of these small areas, in themselves infected by currents in the crop carrying conidia from the soil level up to the leaves.

There is the remarkable fact that this disease does not appear till late in the season. In the season 1928–1929 the disease began in September, in 1929–1930 in January, and in 1930–1931 in December. In the Cheltenham district, in England, the disease may commence in August, but chiefly spreads in October to December, according to Ogilvie, who is keeping the disease under observation in that area. That the seasonal variation is connected in some way with temperature is quite likely; yet temperature cannot be entirely the cause. If the disease were connected with low temperatures, why should it start in August in the south of England and in September in Scotland, for if anything, the low temperatures would be later in appearing in England than in Scotland? Higher temperatures might explain the difference between the two localities, and to a less certain extent between the seasons. Infection might take place at the higher temperatures of July or early August in both localities, but the higher range in England might lessen the incubation period, and so the first signs appear in August, while the lower range in Scotland, although high enough for infection, might increase the incubation period as compared with England. This may be quite likely. It is significant that the mean temperature for the Bristol area, Bath being the station, including Cheltenham, is 61·5° F. in July, 60·7° F. in August, and 56·7° F. in September; while for the Edinburgh district, Leith being the station, the mean is 58·6° F., 58·3° F., and 54·7° F. for July, August, and September respectively. The optimum temperature for conidial production is 15–18° C. (59–64·4° F.), and the fact that the Bath mean temperatures for July and August fall within the conidial optimum, while those of Leith do not, suggests that there may be some correlation there.

It has been suggested that the onset of disease corresponds with the winter checking of host growth. But this is not so easy to support as the previous supposition, as the host growth is more likely to be checked first in the Lothians and later in the Cheltenham district, while the disease appears in Cheltenham before it does in the Lothians.

Life-history and Morphology of the Parasite.

The *Phytophthora* responsible for the disease grows very well on Quaker Oat Agar, producing a dense, white mass of aerial mycelium but not much submerged mycelium. Sexual organs are formed in the medium and on the aerial hyphae, where also conidia are formed. In plate cultures there is a margin of 5 mm. where no aerial mycelium is formed, while immediately adjoining the margin is a dense mass of white hyphae. There is also a marked striation from the centre. On Maize Meal Agar and Potato Agar growth is rather similar but less vigorous. On Potato Dextrose Agar cultures are similar to the above, but whereas oospores are plentiful before seventeen days, conidia are absent. On Malt Extract Agar growth is very poor and exceedingly slow, and aerial hyphae are almost absent. Colonies are solid and show radial striations. Sexual organs are produced very sparsely after four months. On Nucleic Acid Agar growth is slow and almost entirely submerged. Sexual organs are not produced. On Clear Maize Agar growth is rapid and regular, but aerial mycelium is sparse. Sexual organs are formed, and this medium was used for observing their development. As certain species resembled this fungus in one or two characters, they were grown at the same time at 25° C. on Clear Maize Agar. In seven days the Leek *Phytophthora* had a diameter of 27 mm., *Phytophthora Richardiae* was 44 mm., and *Phytophthora pini* was 76·5 mm. The fungus was grown on plate cultures of 10 c.c., 12·5 c.c., 25 c.c., and 50 c.c. of Quaker Oat Agar, and in eleven days measured 80 mm., 77 mm., 53 mm., and 50 mm. respectively. This suggests that the fungus grows into the medium as this increases in depth, to approximately 2–3 mm., and then no increase in depth will influence its area ; it is suggested that the fungus is aerobic and will not grow deep, as reasonable aeration soon becomes impossible.

It was found that this fungus grows saprophytically in the soil. Petri dishes containing sterilised soil were inoculated with pieces of cultures of the fungus, and when the mycelium had grown well over the soil, transfers were made from this to fresh plates and in these the fungus continued to grow. It can therefore obviously grow in soil apart from food contained in the piece of culture. In these soil cultures oospores and conidia were produced abundantly. This adds yet another *Phytophthora* to the many which De Bruyn (3) has succeeded in growing saprophytically in the soil.

General Description.

(*a*) *Mycelium.*—The mycelium of this fungus is typical of the genus but exhibits the characteristics to an extreme degree. It is very granular and branches only moderately. Septa are rare in young cultures but fairly frequent in old cultures, particularly those on rich media. The species has a characteristic which tends to differentiate it from other species; this is its great tendency to coil into one or more spirals, and this is more noticeable in the region of sexual activity. The mycelium is also rather unequal in width and often swells out into large, long vesicals which do not represent any form of spore. It is often swollen considerably where it branches. The submerged hyphae seem very rich in fats, for when they are broken immense quantities of fat globules escape. When fairly old the mycelium becomes empty, as in most species in the genus.

(*b*) *Sexual Organs* (figs. 1 and 2).—These are produced quite abundantly in several media, such as Quaker Oat, Maize Meal, and Clear Maize Agars. They are also produced very readily in the diseased tissues of Leeks. Sterile pieces of mycelium, produced in the method used by Leonian (11), formed them in certain liquid cultures as well. In this species both types of antheridia are produced abundantly, but the proportion of the one to the other varies with the medium or substratum in which they are formed. On Quaker Oat Agar the paragynous type is very dominant, but the amphigynous type is still common. On Maize Meal Agar the proportion is practically 50 : 50, while on Clear Maize Agar the dominant type is amphigynous.

There was a chance that the amphigynous and the paragynous antheridia were produced by two different species obtained in culture, one or other or both being responsible for the disease. It would no doubt have been difficult to have separated these had this been correct. By very careful tracing of the two types of antheridia, the hyphae which produced them were seen to arise from a common mycelium. Cultures which had been taken from the edges of colonies in petri dishes, a quantity of branching mycelium produced from a single hypha being used, gave both types of antheridia. Therefore this should dispel not only any doubts as to whether two species were present, but also any doubts as to the presence of heterothallism in the genus. Narasimhan (13) found that certain strains isolated from various plants in Mysore were non-sexual, but that when two were paired, sexual organs were formed, while when one of these and still another strain were paired, no sexual organs were formed. He argued from his results that one strain was female and the other two male, and only when one or other of the male strains were paired with the female strain could sexual organs be produced. But although heterothallism occurs in some species it does not follow that every species will be heterothallic. In the case of the Leek *Phytophthora* and other homothallic species, there may be generic characters which determine the production of the two types of antheridium, and their proportion may be further influenced by various external factors.

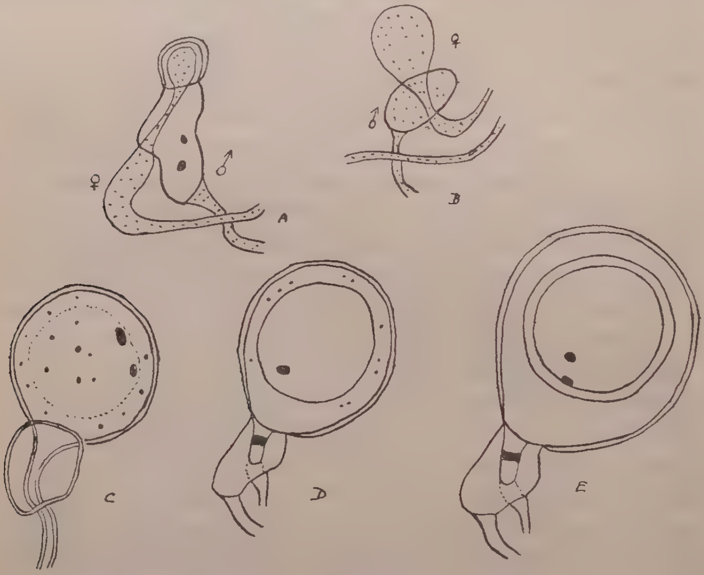


FIG. 1.—*Phytophthora Porri*. Diagrammatic sketches of amphigynous fertilisation. A and B. Passing of the oogonial incept through the antheridium. C. Disintegration of nuclei and collection of cytoplasm for oosphere. D. Oosphere formed. E. Oospore formed, with female and male (peripheral) nuclei shown.

The amphigynous antheridium is produced in the same manner as already described for *Phytophthora erythroseptica* by Pethybridge (15).

The paragynous antheridium attaches itself to almost any part of the oogonium, sometimes being so close to the stalk of the oogonium that it appears to be amphigynous. More than one may be attached to the one oogonium sometimes, and once an oogonium had both an amphigynous and a paragynous antheridium.

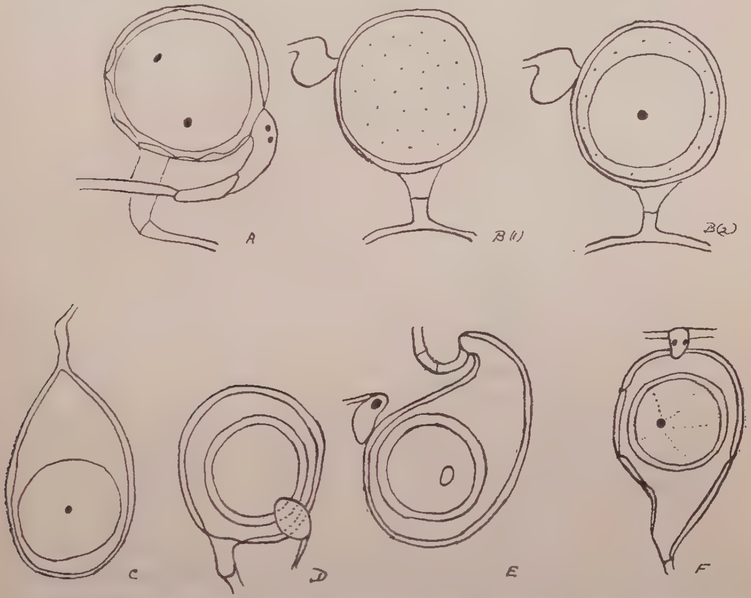


FIG. 2.—*Phytophthora Porri.* Diagrammatic sketches of paragynous fertilisation. A. Oosphere formed. B (1). Stage prior to B (2), the oosphere stage. C. Oosphere. D–F. Oospore stages. F. Showing irregular wall of oogonium in particular.

The oogonial wall is rather thicker than in some species and is hyaline. After the oospore is mature the oogonium tends to collapse and presents a very irregular shape. The oospore is spherical, usually light yellow in colour, with a wall which is thicker than usual. It usually does not fill the oogonium. Not only is the oogonial wall liable to collapse, but it is often irregularly thickened. This is also found in the oogonia of *Phytophthora Lepironiae.*

(*c*) *Asexual Organs* (fig. 3).—Conidia are the only asexual form so far found in this species. They are produced in the diseased leaves as well as in artificial culture, but in the latter they are not very abundant. They are produced more readily if pieces of pure cultures are placed in water and certain liquid cultures. They are inversely pyriform, with or without an apical papilla. When this is present it is broad more often, though a beaked kind is also sometimes formed. The hyaline thickening at the apex is not very prominent and might be said generally to be shallow. The non-papillate form is far the more common. They may germinate either by germ tube or by zoospores. The formation of the zoospores and their emission is similar to that already described for many other species of *Phytophthora*. The zoospores germinate by a germ tube which develops into a mycelium. But in this species repetitional diplanetism has been found, though only once, nor could the phenomenon be repeated. When the zoospores are emitted they swim only a short distance, then settle down, form a wall, and germinate by a short tube from the end of which another zoospore is emitted. In other words, the primary zoospore acts as a sporangium. All the contents of the first zoospore pass into the new zoospore, and this breaks away, swims normally, and ends up by germinating in the usual way to produce a mycelium. Drechsler (7) found another type of diplanetism in which the zoospore after encystment produces a long, slender germ sporangiophore, at the tip of which a small sporangium is formed. This may also be formed from an unsuccessful evacuation tube. The miniature sporangium forms one zoospore from its contents, and this is liberated. The latter method has not been found in this fungus so far.

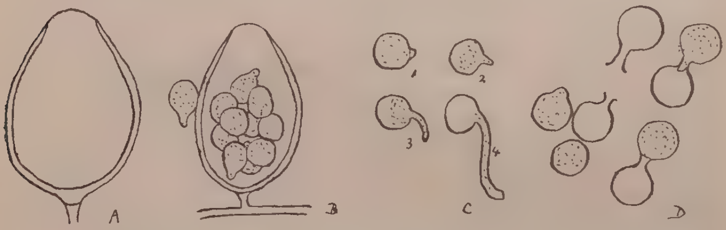


Fig. 3.—*Phytophthora Porri*. Diagrammatic sketches of conidial stages. A. Terminal conidium. B. Intercalary conidium with half the zoospores unexpelled. C. Germinating zoospores. D. Diplanetic zoospores, two of which have not broken away from the mother zoospore.

It often happens that the zoospores are not liberated from the sporangium, and these encyst and germinate by a tube, which may grow through the sporangium wall. The number of zoospores produced in the sporangium depends upon the size of the latter. Over twenty have been counted from one sporangium, while in others a few were left inside the sporangium and others were bunched outside; the numbers could not be determined with certainty, but they were between fifteen and twenty. A small kind of sporangium has been found in this fungus, which is more spherical than the normal type and forms only a few zoospores, perhaps three to five. These were not the miniature sporangia produced from zoospores referred to before. They have not been found again. They were produced in a hanging-drop culture on Clear Maize Agar, the same in which the diplanetic zoospores were produced. Neither have been seen in liquid cultures as described by Dreschler. According to him, the direct type of repetitional development of the zoospore was observed in *Phytophthora Fagi*, the indirect type in *Phytophthora hibernalis*, and both types in *Phytophthora parasitica* and some strains referable to it, *Phytophthora Cactorum*, *Phytophthora citrophthora*, *Phytophthora melongenae*, and a strain from Honey-dew Melon.

The direct germination of the sporangium by a tube may take place either at the apex or just below it. The sporangia are produced at the ends of hyphae and also intercalarily. The sporangiophore may be inserted in the usual place, at the centre of the broader end, or on one side. No plano-convex sporangia have been noticed, as was found by Leonian in *Phytophthora pini*. A few sporangia, both in water culture and in tissue, have a pedicel.

MEASUREMENT OF THE FUNGUS.

(*a*) *The Mycelium.*—This varies rather considerably according to whether it is aerial, when it is thin, or in the substratum, when it is thick. Rich media tend to produce very variable hyphae which swell out into odd shapes. There is no stability in the mycelium in the tissue either. The average width approximates 6–8 μ, and the range is about 2·4–12 μ.

(*b*) *The Sexual Organs.*—Precautions were taken to measure only mature organs.

TABLE I.

Measurements in μ of the Sexual Organs.

Substratum.	Oogonia.		Oospores.	
	Mean.	Range.	Mean.	Range.
Quaker Oat Agar	38·367	46–29	32·369	39–23
Water	37·864	44–33	31·679	39–22
Bog Water	38·966	44–32	33·144	39–27
$MgNO_3$ (1 : 1000)	39·123	46–34	32·272	39–27
Tissue	34·596	44–29	29·022	36–19

The writer's figures which were given in the first record of the disease (8) were not representative and should be replaced by the present figures.

It is to be noticed that the oogonia and the oospores in the host are much smaller than those in solid and liquid culture.

The mean of the organs may therefore be stated to vary between 38 and 39 μ for the oogonia, and between 32 and 33 μ for the oospores.

The antheridia average 12·5 μ but range from 7·3 to 19·4 μ. One abnormal one was found in magnesium nitrate solution and measured 24·2 μ. The amphigynous antheridia are usually larger than the paragynous, being approximately twice the size.

The oospore wall, which has three layers as described for *P. erythroseptica*, varies between 3 and 4·5 μ thick, the average being about 4 μ. The outer layer is about 0·4 μ and the inner 0·2 μ, the rest, 3·4 μ, being the middle layer. It is rather a thick wall when compared with some other species.

(*c*) *The Asexual Organs.*—The conidia also vary in size according to the conditions of production. On the leaf they tend to be larger than when they are produced in solid culture or in liquid culture. Only normal, mature spores were measured.

TABLE II.

Measurements in μ of Conidia.

Substratum.	No.	Mean.	Range.	Mode.
Host . .	100	58 × 42	75–37 × 48–31	1·38
Water . .	200	51 × 35	82–31 × 52–23	1·46
Soil . .	10	46 × 32	55–31 × 42–28	1·44
Water [1] . .	?	47·9 × 32·9	62–33 × 45–25	1·46

[1] These measurements were kindly made by Dr. Ashby, to whom the author sent a culture.

The question arises as to what measurements are to be taken for comparative purposes. These conidia are not like those of *Phytophthora infestans*, which are produced naturally and abundantly aerially on the leaf, or on diseased tubers when cut and kept in a humid atmosphere. They are produced in culture, but not enough to use them for metrical purposes, particularly when they are produced abundantly in liquid culture. For this purpose a survey of the species thought to be nearest to this one must be made. This will be deferred for the moment and discussed under the subject of taxonomy.

The wall of the conidium is approximately 2·4 μ thick, except at the apex. There is a plug at the point of production of the conidium on the conidiophore. The proportion of the length to the width of the conidia is rather constant, and is 1·46.

The papillae when they are present are about 5 μ high and the width of the apex is about 10–12 μ. The beaked forms of papillae are usually 12 μ long.

The zoospores vary in size. The usual size is about 10–15 μ, that is when they have stopped swimming and rounded off. But the kind which produced secondary zoospores were larger, averaging, when they had rounded and produced the emission tube, 18·7 μ, and ranging 17·4–20·4 μ. The tube that is formed is about 5 μ long, but longer ones, up to 10 μ, are also produced.

The Relation of Temperature.

Petri dishes of Maize Meal Agar were inoculated with a 3-mm. square of a culture of *Phytophthora Porri* and grown at three different temperatures—in an incubator at 25° C., in the laboratory at 18°–20° C., and in a glass-house at 8°–10° C. The rates of growth are very different.

It was found that the fungus grew best, vegetatively, at 25° C. and that the minimum must be below 8° C. Cultures kept in an incubator running between 30° and 33° C. hardly grew at all, while cultures at 40° C. were killed. It may be concluded that, within the ordinary limits of variation, the minimum, optimum, and maximum temperatures for the vegetative growth of the Leek *Phytophthora* are below 8° C., 25° C., and 35° C., while the death-point is at or slightly below 40° C.

Temperature also influences the production of conidia in liquid cultures, though not entirely. Conidia are produced at 23°–25° C., but are very few and are very small and slender. They are really abnormal. At room temperature, 18°–20° C., they are produced fairly well, but abundantly at 15°–18° C. At 10° C. no conidia are produced. These relations seem to place the Leek *Phytophthora* in the temperate group. Temperate species chiefly produce conidia at temperatures between 16° and 25° C., while tropical species require temperatures above 20° C., maximum production occurring at 27°–30° C. For example, Jones, Giddings, and Lutman (9) found the maximum number of conidia of *Phytophthora infestans* at 16°–18° C., but not below 10° or above 23° C. With the same fungus other workers obtained higher temperatures for the best conidial production; Vowinckel (26) obtained 19°–22° C. and Melhus (12) 22°–25° C. Rose (17) found the optimum temperature for *Phytophthora Cactorum* was between 10° and 20° C. Uppal (25) found 22°–23° C. was optimum for *Phytophthora Colocasiae.* Waterhouse (27) found that her cultures of *Phytophthora Fagi* produced conidia in three days at 15°–20° C. but none at 22° C. Ashby (1) found that the more tropical species *Phytophthora parasitica* had an optimum conidial temperature of 27°–30° C., and Reinking (16) with *Phytophthora Faberi* (= *Phytophthora palmivora*) found an optimum of 27°–30° C. also, but no conidia were produced below 20° C. Although conidia of *Phytophthora Fagi* were produced best at 15°–20° C. according to Waterhouse, the best vegetative growth of the same fungus was at 22° C. This is similar to *Phytophthora Porri*, although the temperatures are not exactly the same.

THE RELATION TO LEONIAN'S PHYSIOLOGICAL KEY.

The method used by Leonian (11) for determining the effect of chemicals on the production of conidia and oospores in culture was used by the writer. The procedure was as follows. A small portion of a Quaker Oat culture of the fungus was placed in a petri dish containing a nutrient solution made up according to Leonian's formula. As no growth was made in this culture it was taken out and washed in running water for an hour and then transferred to a petri dish with fresh nutrient solution. After three days good vegetative growth had been made, but as there were a few bacteria the colony was again washed in running water and replaced in fresh solution. The growth was now very good, and two small pieces were teased off the large colony with sterile forceps and one each placed in a dish. A set of petri dishes was now poured with solutions containing one-hundredth the molecular weight of various chemicals and each inoculated with a piece of colony from each dish. The results are given in Table III.

TABLE III.

Effect of Chemicals on Spore Production in P. Porri.

Aspartic acid	None.
Potassium nitrate	Sporangia.
,, carbonate	None.
,, acid phosphate	None.
Calcium nitrate	Sporangia.
Sodium chloride	Sporangia.
Ammonium nitrate	None.
,, sulphate	None.
Magnesium sulphate	Sporangia.
Dextrose	None.
Glycine	Sporangia; oogonia.
Levulose	Sporangia.
Mannose	None.
Leucine	None.
Nutrient solution	None.

Oogonia are produced on Malt Extract Agar, and no oogonia and no sporangia are found in Nucleic Acid Agar.

By the colonies produced on Malt Extract Agar and the absence of sporangia in Aspartic Acid group six of Leonian's key is reached, and the formation of oogonia in Malt Extract Agar places the fungus in group seven. The absence of sporangia in Leucine or Ammonium Sulphate would identify the fungus as *Phytophthora pini.* If it were conceded that the number of oogonia on Malt Extract Agar were too few and could be taken as equalling Class I of Leonian's analysis, this would take the fungus into group eight of the key. No sporangia are produced in nutrient solution and no chlamydospores are produced in any medium. The finding of sporangia in potassium nitrate and in sodium chloride solution, but not in mannose solution, places the fungus in group fifteen. As sporangia are produced liberally, at room temperature, in water although not in leucine, this would identify the fungus as *Phytophthora Nicotianae.* No other than the two species mentioned can be considered from the results of the physiological experiments and using Leonian's key. There are reasons otherwise for rejecting both of these two species.

TAXONOMY OF THE FUNGUS.

No *Phytophthora* has been recorded on the Leek (*Allium Porrum*) before; nor has any other species of *Allium* been recorded as naturally infected by a *Phytophthora* except *Allium fistulosum*, the Japanese Welsh Onion, which was found to be attacked in Formosa in 1913 by a new species erected as *P. Allii* by Sawada (18). The fungus *P. Allii* did not infect *Allium Cepa.* The present strain was therefore compared with *P. Allii* and was found to be quite different.

Never has a single onion (*Allium Cepa*) been found affected with White Tip disease, although leeks and onions have been grown in proximity for years. But it is agreed that the host of a *Phytophthora* is not an indication of its identity. Several species attack many hosts, e.g. *P. parasitica* and *P. cryptogea.* That one species has been recorded on a certain host is no reason why a newly discovered species on a different host should not be identical with the first. The Leek *Phytophthora* has no right to a binomial such as *P. Porri* just because no *Phytophthora* had been found on that host. Nor can the Leek *Phytophthora* be distinguished from *P. Allii* because the latter is on a different host. Identification has, in the past, been associated with morphological features, such as shape, type, presence and size of sexual organs, or asexual reproductive bodies. Since it has been demonstrated that the morphological characters and life-history can be varied by the influence of external factors, they cannot be entirely reliable for diagnostic purposes. Leonian (11) made a key for the identification of the species in the genus *Phytophthora* based on physiological characteristics, but it is claimed for the fungus described here that the key is not sufficient to identify it, as shown above in the experiments conducted similarly to Leonian's method. The trouble with the keys so far formulated is that they only take into consideration the species already discovered. It is the new strains of *Phytophthora* which upset the keys, for surely if they did not do so then they would not be new. In the case of the Leek parasite, each key identifies it as a different species. By Leonian's key (11) it is either *P. pini* or *P. Nicotianae*; by Tucker's key (24) it is *P. Cactorum*. These three species can be compared with the Leek fungus along with others which have one or more characters which approximate one or more characters of the Leek fungus.

It was seen that the Leek fungus has the following measurements in μ :—

Oogonia : mean, 38–39 ; range, 46–29. Culture.
Oospores : ,, 32–33 ; ,, 39–22 ; wall, 3–4·5. Culture.
,, 29 ; ,, 36–19. Host.
Conidia : ,, 58 × 42 ; ,, 75–37 × 48–31. Host.
,, 51 × 35 ; ,, 82–31 × 52–23. Water.
mode, 1·38–1·46.
Antheridia : mean 12·5 ; range 19·4–7·3.

Phytophthora Allii Sawada (18). On *Allium fistulosum*. Formosa.

Oogonia : mean, 20·7 ; range, 26–17. Host only.
Oospores : ,, 16·9 ; ,, 23–14 ; wall, 0·5–1·5. Host only.
Conidia : ,, 49·4 × 36·5 ; range, 74–40 × 50–30. ,,
mode, 1·38.
Antheridia : 18–8 × 14–10, amphigynous only.

Taking into consideration the fact that the measurements are of the fungus on the host only, there is still a great deal of difference between the sexual organs of this fungus and the Leek parasite. The conidia have almost the same range as those on the Leek leaves, although the mean is much lower. The shape of the conidia and the mode are the same in both, and both have hemispherical papillae almost the same size. The Leek fungus has, in addition, the beaked form of papillae. But conidia are the most variable part of the fungus, and many species overlap. This has been included by Ashby in the "microspora" group of *Phytophthora parasitica* emend. This does not approach closely to the Leek fungus.

Phytophthora cyperi-rotundati Sawada (21). On *Cyperus rotundatus*. Formosa.

Oogonia : mean, ... ; range, 47–31 × 45–25. Host only.
Oospores : ,, 30·8 ; ,, 29–22 ; wall, 1–3. ,,
Conidia : ,, 45·4 × 25·1 ; range, 67–22 × 34–14. ,,
mode, 1·81.
Antheridia : Para. 20–13 × 13–11 ; Amphi. 16–13 × 22–19.

It is seen that the range of oogonia approximates to the Leek fungus, while the oospores have exactly the same range in both. In the translated description (from the Japanese) sent by Ashby to the writer, is "Oospores . . . 22–39, mostly 32 ; average (150) 30·8." It is peculiar that the 'mostly 32' is the same as the mean for the Leek oospores. The conidia are smaller and narrower than the Leek conidia. A short, thickened pedicel is present. These are all on the host though, and the oospores on the host in the case of the Leek fungus are 3 μ smaller and have a lower range. This fungus approaches the Leek fungus, but has not been adequately described from the host alone. The disease is prevalent at 25°–28° C., much higher than the Leek disease.

Phytophthora Lepironiae Sawada (19, 20). On *Lepironia mucronata*. Formosa and South China.

Oogonia : mean, ... ; range, 52–40 × 48–40 ; wall, 4 (!).
Host only.
Oospores : ,, ... ; ,, 38–30 ; wall, 3–4. ,,
Conidia : ,, 54 × 44·6 ; range, 64–40 × 52–36.
mode, 1·21.
Antheridia : Paragynous, 24–20 × 16–14.

Here the oospores and oogonia on the host are larger than those on the Leek fungus on the host. The conidia are smaller and broader than the Leek conidia, though similar in being mainly non-papillate. The oogonial wall is unequally thickened, but thicker than in the Leek fungus. Only paragynous antheridia were found in the host tissues. This is less like the Leek *Phytophthora* than *P. cyperi-rotundati.*

Phytophthora Pini Leonian. On *Pinus resinosa* (11).
Oogonia : mean, 29 ; range, 37–18·5.
Oospores : ,, 26 ; ,, 34·2–16·7 (Tucker).
Conidia : ,, 55·5 × 35 ; ,, 92·5–26 × 44·5–22.
mode, 1·59.
Antheridia : Paragynous mostly, also amphigynous.

The size of the conidia is not the same as the Leek fungus, but is near enough if only the oospores were the same size. These latter are much too small, being 26 μ in mean. The antheridia are mostly like the Leek *Phytophthora*, especially in the habit of multi-fertilisation ; the cultural characters are not similar. The narrower conidia, with definite or blunt papillae, of this fungus are not quite similar to the Leek conidia. Tucker makes this synonymous with *P. Cactorum.*

Phytophthora Cactorum (L. & C.) Schroet. On many hosts.
Oogonia : mean, 29·4–26·8 ; range, 38·4–18·4.
Oospores : ,, 26·5–24·2 ; ,, 34·2–16·7.
Conidia : ,, 30·39–22·77 ; ,, 31–17 × 40–23.

The above figures are given by Tucker (24), who states that the antheridia are almost entirely paragynous. The conidia are small and inconspicuously papillate. It grows best at 25°–27·5° C. The measurements do not approximate to those of the Leek fungus, which also has different cultural characteristics.

Phytophthora hibernalis Carne. On Citrus (6).
Oospores : 45·6–22 ; mean, 35.
Conidia : 56–17 × 28–10.
Antheridia : Mainly amphigynous, rarely paragynous.

The conidia are too small, although the average oospore size may be near to that of the Leek fungus. Fuller figures are not given. The cultural characters are different from the

Leek fungus. It seems, in addition, a far cry from a citrus to a leek.

Phytophthora Richardiae Buisman. On *Richardia* (4, 5).
Oospores : mean, 29.
Conidia : ,, 52 × 33.

The antheridia are entirely amphigynous, and its affinity is with *Phytophthora cryptogea.* Indeed Ashby considers *P. Richardiae* merely a variety of *P. cryptogea.* Its growth on media is not similar to the Leek fungus.

Phytophthora Capsici Leonian (10). On *Capsicum annuum.*
Oospores : range, 25–35.
Conidia : ,, 83–35 × 56–21.
Antheridia : Amphigynous.

The measurements are not helpful, as they are only ranges, but taking into consideration the antheridium, the host, the physiology (Leonian's key), and its cultural peculiarities, none of which are similar to those in the Leek fungus, it is almost certainly not the same.

Phytophthora citrophthora (Smith & Smith) Leonian. On Citrus (22, 23, 11).
Oospores : range, 40–30.
Conidia : mean, 50 × 35 ; range, 90–30 × 60–20.

The conidia are very close to those of the Leek fungus, but as it does not form oospores on Oatmeal Agar and forms sporangia and aerial hyphae on Nucleinic-acid Agar, while the Leek fungus does just the opposite, this species need not be considered. The cultural characters are also different.

Phytophthora Nicotianae Breda de Haan (2).
Oogonia : mean, 30 (Ashby), 27·8 (Tucker).
Oospores : ,, 24·3 ,, 23·5 ,,
Conidia : ,, 41·2–35·1 × 25·2–21·7 (Tucker).
Antheridia : amphigynous.

Tucker has renamed this species *P. parasitica* var. *Nicotianae.* The measurements are generally too small to permit the identification of this species with the Leek parasite. Tucker identified *P. tabaci* Saw. with this species. This species also thrives best at high temperatures, the optimum being 25°–30° C., which is higher than that for the Leek fungus.

It seems, therefore, that the species that approach in any measurement to the Leek fungus vary even in these respects and more often in others, such as antheridial type, cultural and physiological characters. The nearest are *Phytophthora cyperi-rotundati* and *Phytophthora Pini*, but in *P. Pini* the cultural characters, the oospores, and partly the conidia are too divergent to connect the Leek *Phytophthora* with it; while in the case of *Phytophthora cyperi-rotundati* the size and shape of the conidia, the pedicel, the slightly larger (host) oospore, and the high temperature of the disease deny a reasonable connection with the Leek fungus also.

The species can be diagnosed as follows:—

Phytophthora Porri, n. sp.

Mycelium ramosum, in juventate non-septatum, tandem multi-septatum atque vacuum, in regione sexuali in spiras contortum. Conidia inversi-pyriformia vel ovalia, 51 × 35 μ (82–31 × 52–23 μ), ad apices conidiophororum producta vel intercalaria, plerumque papilla deficiente, nunc papilla lata 5 × 10–12 μ nunc papilla rostrata 12 × 10–12 μ praedita; callositas apicalis hyalina 2·5–5·0 μ crassa; ostiolum latum; conidium ipsum in germinatione evolvit vel tubum vel zoosporidia 10–15 μ quae iterato zoosporidia producunt vel nunc tubum. Antheridia ovalia vel complanato-sphaerica, terminalia vel intercalaria, in eadem hypha unà cum oogonio haud inventa, aut amphigyna 12·5 μ (19·4–7·3 μ), aut paragyna 10–7·3 μ. Oogonium maturum sphaericum, muro inaequaliter incrassato munitum, 38–39 μ (46–29 μ), fecundum antheridio paragyno unico plerumque adjuvante, nunc pluribus, nunc antheridio amphigyno, nonnunquam ambobus eodem tempore. Oospora sphaerica, maturitate melleo-flava, 32–33 μ (39–22 μ), muro crasso 3–4·5 μ cincta. Conidia in aqua atque in hospite abunde producta, in cultura solida infrequentia; genitalia in cultura solida vel liquida atque in hospite creberrima. In foliis caulibusque *Allii Porri* Linn. parasitica, ubi areolas aquosas, tandem albescentes praesertim ad apices foliorum inducit. Hab. in ins. Britannicis.

Mycelium branched, non-septate when young, septate and empty when old, coiled in spirals in region of sexual activity. Conidia inversely pyriform or oval, 51 × 35 μ (82–31 × 52–23 μ), produced at the end of conidiophores or intercalary, usually without a papilla, occasionally with a broad papilla 5 × 10–12 μ, sometimes with a beaked papilla 12 × 10–12 μ; apical thickening 2·5–5·0 μ and hyaline, mouth of discharge broad, germination by a tube or by zoospores 10–15 μ, which may germinate in turn by zoospores (repetitional diplanetism) or by a germ tube. Antheridia oval or flattened spheres, terminal or intercalary, not on the same hypha as oogonium; when amphigynous 12·5 μ (19·4–7·3 μ), and when paragynous 10–7·3 μ. Mature oogonium spherical, with an unevenly thickened wall, 38–39 μ (46–29 μ), fertilised mostly by one paragynous antheridium, sometimes by several paragynous antheridia, sometimes by an amphigynous antheridium, and sometimes by both types at once. Oospore spherical, honey-yellow when old, 32–33 μ (39–22 μ), with a thick wall 3–4·5 μ. Conidia produced abundantly in water and in the host, less often in solid media; sexual organs formed abundantly in solid and liquid media and in the host. Parasitic on the leaves and stems of *Allium Porrum* Linn., causing water-logged areas, followed by a whitening of the tips of leaves and other affected parts. Hab. in Great Britain.

CONTROL.

It is too early to say much on the control of this disease as work is still proceeding on this line. But in 1928, when trials were started to control Downy Mildew of Leeks—which turned out to be this disease—three sprays were used. They were Bordeaux and Burgundy mixtures and Ammonium Polysulphide wash. To each was added soft soap to aid adhesion, as liquids roll off the waxy leaves of Leeks very readily. Although the Leeks were already infected when sprayed, it was found that the Ammonium Polysulphide had the best effect in reducing the intensity of the disease. In England, Ogilvie and Mulligan (14) used a Copper-Lime dust, and have reported fair success in controlling the disease. In Scotland conditions are not so suitable for the use of a dust, but further trials are to be made of various possible controls.

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SUMMARY.

A disease of Leeks called "White Tip" is described which in the last few years has become of considerable economic importance. The symptoms include the yellowing and dying of tips of leaves, which turn white, and water-logged areas which develop lower down. The parasite is a *Phytophthora*; its presence in the host and its isolation and growth in artificial culture are described. Infection experiments did not support a hypothesis of root or basal attack, but supported leaf attack. The parasite grows in the soil saprophytically, produces conidia on the soil surface, and these are supposed to be blown on to leaves, whence infection takes place. The seasonal appearance of the disease is discussed and some meteorological factors are given in explanation of its later appearance in Scotland than in England. The life-history, morphology, and physiology of the parasite is described in detail, and comparison is made with several species. It is decided that it is a new species and is named *Phytophthora Porri*, with a diagnosis in Latin and English. Control measures are discussed, but have not been properly worked out yet.

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STUDIES IN VEGETATIVE PROPAGATION: ACALYPHA, DIOSCOREA, AND STENOGLOTTIS LONGIFOLIA. By R. J. D. GRAHAM and L. B. STEWART. (With Pl. XIX.)

(Read 23rd April 1931.)

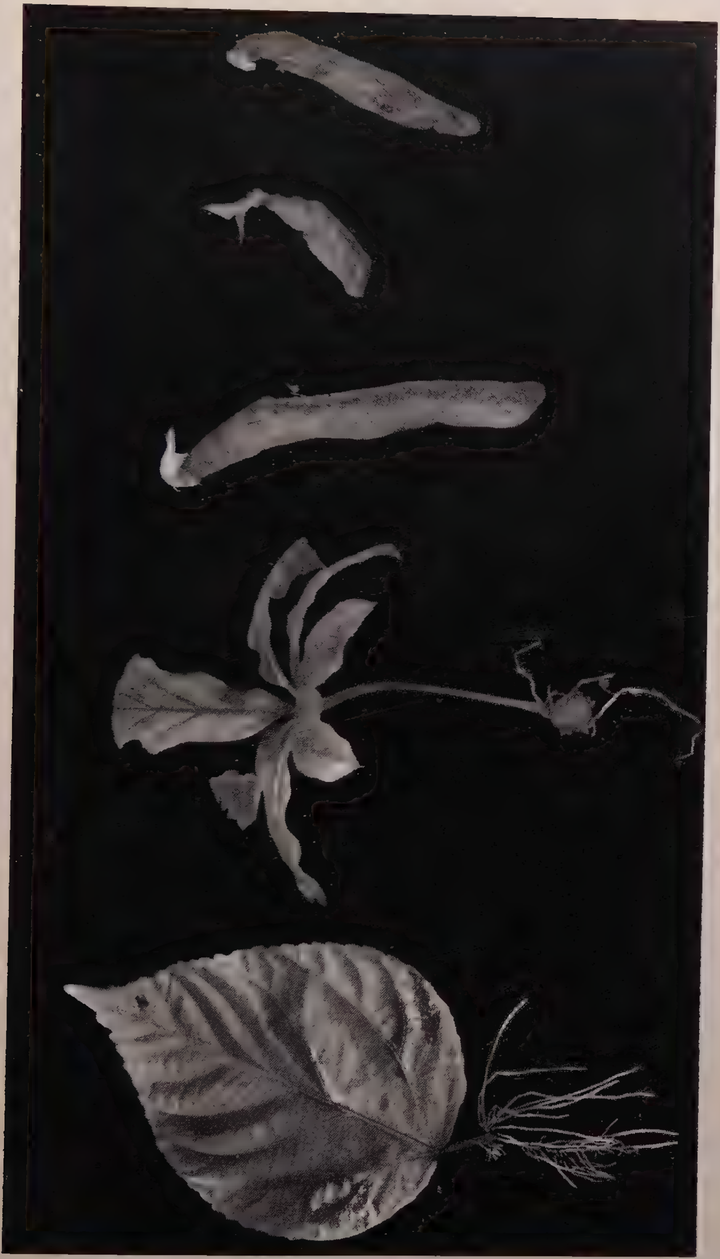
Attention was drawn in a paper (Acad. Wetenschapp. Amst. Proc., Sect. Sc., xxxii (1929), 35) by F. W. Went to *Acalypha Wilkesiana*. The author reported a specific root-producing substance in the leaf, but stated that the leaf itself did not produce roots.

The latter part of this statement is contrary to our experience in certain other species of *Acalypha*, whose leaves rooted freely. The species used in our propagation had green leaves whereas *A. Wilkesiana* has red leaves. Since the conditions inducing the development of anthocyanin are known to inhibit root development in regeneration among certain plants the matter was put to the test.

In October 1930 leaves of *A. Wilkesiana* were placed in the propagating frame. Within ten days the majority had rooted, the remainder rooting within the month. Root-production is not only possible but expeditious, and is so abundant that within three months the root system completely filled a 3-inch pot. Leaves with petioles rooted from the base of the petiole, the root development being more copious on the abaxial side (fig. 1). Leaves detached from their petioles root freely from the injured base of the lamina. Laminas in which the veins were incised also rooted freely from the lower end of the severed veins.

Anatomical investigation revealed the fact that root development is initiated in the cells of the vascular bundles external to the xylem. In one microtome section seven of the nine bundles in the petiole showed root initials.

Records of leaf propagation in Monocotyledons with ordinary—not fleshy—leaves are uncommon. In order to increase the number of records the leaves of various Monocotyledons, among them Dioscorea, were experimented with. Success attended the experiment both in simple-leaved Dioscoreas and in those with compound leaves.



1. *Acalypha Wilkesiana.* 2. *Dioscorea.* 3. *Stenoglottis longifolia.*

R. J. D. Graham and L. B. Stewart.

Material was insufficient for detailed anatomical investigation, but the growth form of the new plant is interesting (fig. 2). It consists of a swollen tuberous portion attached to the parental leaf. The tuber bears numerous fibrous roots. No leaves are formed in the first year, the parental leaf being the sole photosynthetic organ of the developing plant. On the death of this leaf the tuber forms the perennating organ for the new plant.

Root propagation of *Stenoglottis longifolia*, an orchid, presents several features of interest. Propagation is most successful from roots showing constricted areas if these roots are severed at the constriction. Callus originating from the parenchymatous cortex of the root develops. This callus in horizontally placed cuttings develops towards the upper side of the horizontal root. On the upper side of this callus, buds are produced, originating from all groups some distance below the surface (fig. 3). Vascular connection between the developing bud and the root is supplied by short spiral tracheids which link up the new plant with the old root.

ANOMALOUS STEM STRUCTURE IN RUSCUS ACULEATUS LINN. By HAMISH BOYD GILLILAND.

(Read 21st May 1931.)

Ruscus aculeatus Linn. (Lond. Cat. Brit. Plants (1925), No. 1850) is a rhizomatous shrub. New shoots from the rhizome appear above ground in May and these shoots flower in the following spring.

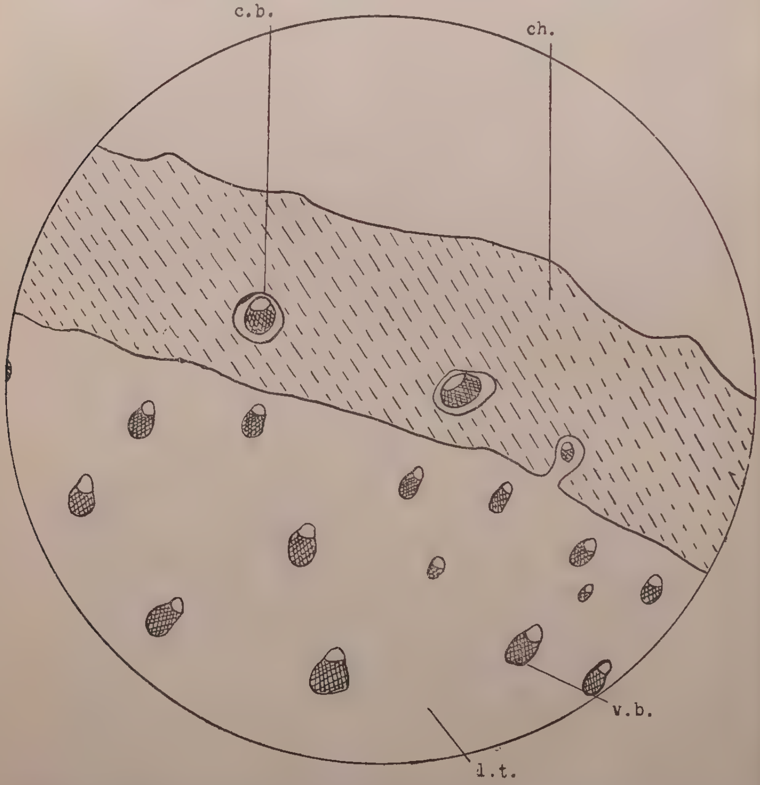


FIG. 1.—Portion of a section of mature stem of *Ruscus aculeatus* Linn. c.b. = cortical bundle; ch. = chlorenchyma; l.t. = lignified tissue; v.b. = vascular bundle.

The axes of these flowering shoots consist of a hollow cylinder of chlorenchyma surrounding a central solid cylinder of lignified cells in which the bundles of the vascular system are dispersed. The epidermis is strongly cuticularised.

In some cases (fig. 1) in the cylinder of chlorenchyma complete vascular bundles are present which either, after their course through this cortex, pass to a lateral appendage or rejoin the central lignified cylinder.

Sections of a young bud show the lignification to be confined to the protoxylem, later to have spread to metaxylem, but it is not till a very late stage that the central cylinder of lignified cells differentiates from the ground tissue.

The plant is structurally a xerophyte, leaves being reduced to scales, branches modified as phylloclades, and the general cortical tissue consisting of chlorenchyma.

The development of chlorophyll in the cortex precedes the lignification of the central cylinder, and it is suggested, in some cases, by penetrating the distal layers of what would normally differentiate as the central cylinder, inhibits there the process of lignification, leaving some peripheral bundles surrounded by a non-lignified tissue.

Similar inhibition by preformation of chlorenchyma would apply to non-lignification in homologous regions of the cladode.

The anomaly therefore rests not so much in the " cortical " position of the bundles of the vascular system as in the distribution of the lignified and chlorenchymatous tissues.

The sequence of events in the differentiation of these two tissues is being investigated in greater detail.

EVOLUTION IN THE MONOCOTYLEDONOUS SEEDLING: A NEW INTERPRETATION OF THE MORPHOLOGY OF THE GRASS EMBRYO. By LUCY BOYD, D.Sc.

(Read 18th June 1931.)

The structure of the grass embryo still remains the most controversial question in seedling morphology. The present publication deals briefly with the matter from a new standpoint. One result of a research extending over four years on monocotyledonous seedlings has been the acquiring of information not available to previous writers formulating theories on the embryo of Gramineae. Observations on the seedlings of a large number of genera have led the author to the conclusion that seedlings of the phylum are apparently subject to certain trends. In order that a general perspective be obtained, a discussion of the latter will form an introduction to the treatment of the grass embryo in particular. The evidence on which the following views are founded will, it is hoped, be published in full at an early date.

TENDENCIES OF MONOCOTYLEDONOUS SEEDLINGS TOWARDS AN ADVANCED TYPE.

(a) *From the Epigeal to the Hypogeal Habit.*—This tendency is suggested by a consideration of those families retaining epigeal germination and of the numerical relationship between the two types. Morphologically, epigeal and hypogeal seedlings are identical. There is a physiological distinction in that the former have cotyledons which manufacture food in addition to conducting it. Schlickum (17) has commented upon the advantages of hypogeal germination, namely, added protection to the plumule and more effective anchorage of the seedling.

(b) *Towards Earlier and Stronger Plumular Development.*—Unless endosperm is plentiful, the early appearance of photosynthetic organs is an urgent necessity.

(c) *From the Non-ligulate to the Ligulate Type of Cotyledon.*—The origin of the ligule, a closed tube of varying length en-sheathing the plumule, has been already discussed by Schlickum (17), Sargant and Arber (15). Its significance as an organ for the protection of a rapidly developing plumule is apparent. Certain families, *e.g.* Commelinaceae, are at a transition stage, while the greater number of species with a ligulate cotyledon occur in the most advanced families (fig. 1).

(d) *Towards Decreasing Importance of the Radicle.*—Seedlings having ligulate cotyledons usually exhibit advanced differentiation and rapid growth of the plumule. In such the radicle tends to be increasingly dominated by the latter until extreme cases occur where the primary root does not appear as a distinct organ. Two suggestions regarding such a limitation may be made. The quantity of raw material and space at the disposal of the embryo is to a certain extent fixed. Marked development of one organ, such as the plumule, will take place at the expense of another. Further, the rapid production of foliage leaves results in a strain on the vascular

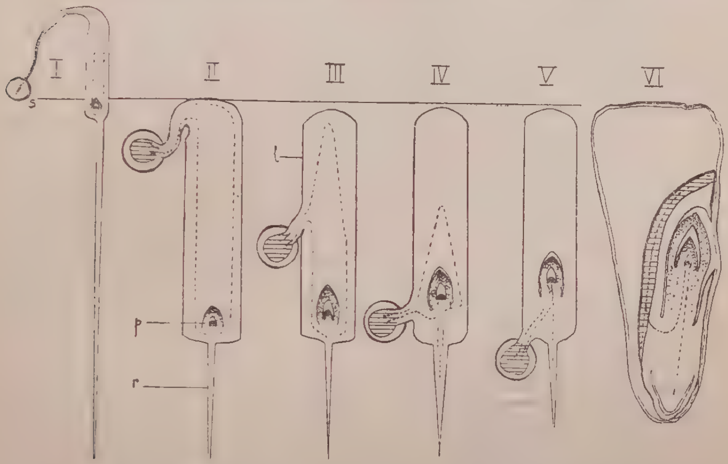


FIG. 1, i–vi.—Series of monocotyledonous seedlings indicating a gradual transition from a simple epigeal type (i) to a pronounced hypogeal ligulate type with consequent reduction in the length of the cotyledon strands (indicated by dotted line). Intermediate stages are shown in such instances as the Commelinaceæ (iii). The grain of *Avena sativa* (vi) shows intra-seminally the differentiation and orientation of organs exhibited by the seedlings of the Zingiberaceæ (iv) and (v). (Diagrammatic.)

p = plumular bud.
s = surface of soil.
r = radicle.
l = ligule of cotyledon.

supply of a single primary root incapable of secondary thickening. There is a consequent need for an adventitious root system.

(e) *Towards Economy in the Vascular System of the Cotyledon.*—From a study of the anatomy of monocotyledonous seedlings it appears to the writer that the vascular tissue of the cotyledon is disappearing. A lengthy reduction series can be traced from seedlings of relatively primitive families with many cotyledonary strands, through the central Liliaceous type with a double bundle or single strand, to the extreme case in which the cotyledon is almost completely devoid of vascular tissue. A complete consideration of such a series and its relation to Sargant's widely accepted theory of the origin of the seed leaf of monocotyledons (14) does not lie within the scope of the present discussion. Three instances will be furnished of genera in which the cotyledon has apparently lost almost its entire vascular supply in order that direct communication may be established between the plumular bud and the suctorial tip imbedded in endosperm.

(f) *Towards Increasing Embryonic Development before Germination.*—This tendency is parallel to the gradual acquisition of a ligulate cotyledon, and affects not only the differentiation of the organs, but their relative orientation. In epigeal germination the cotyledon, plumule and radicle of the seedling finally lie in the same vertical straight line (fig. 2, 5*a*, 5*b*); the same is true in hypogeal germination, but the cotyledon tip and stalk are not in alignment with the other organs.

FIG. 2.—1. Embryo of *Avena sativa* in longitudinal section. The missing portion of the ligule between epiblast and ventral scale is indicated by a double dotted line. 2. Seedling, one week old, of *Hedychium Gardnerianum*, for comparison with *Avena*. 3. Ripe embryo of *Bambusa arundinacea*, in longitudinal section, showing primitiveness, since it attains in its ontogeny a stage comparable with the embryo of *Billbergia zebrina* (6*a*) (sketched from a preparation by W. E. Evans). 4. Young embryo of *Oryza sativa* in longitudinal section (after Bruns). 5*a*, 5*b*. Germination of a simple epigeal monocotyledonous seedling, the axis of the organs being in a vertical line. 6. *Billbergia zebrina*. *a*. Ripe embryo; compare orientation of organs and vascular anatomy with that of *Bambusa*. *b*. Seedling two days old. *c*. Seedling ten days old; the final orientation of sucker root and shoot has been reached at this stage, *cf.* embryo of *Avena sativa*.

c = cotyledon.
e = epiblast.
en = endosperm.
l_1 = first leaf.
lig = ligule.
mes = "mesocotyl."
r = radicle.
r′ = adventitious root.
s = sucker.
sc = scutellum.
t = testa.
v.s. = ventral scale.

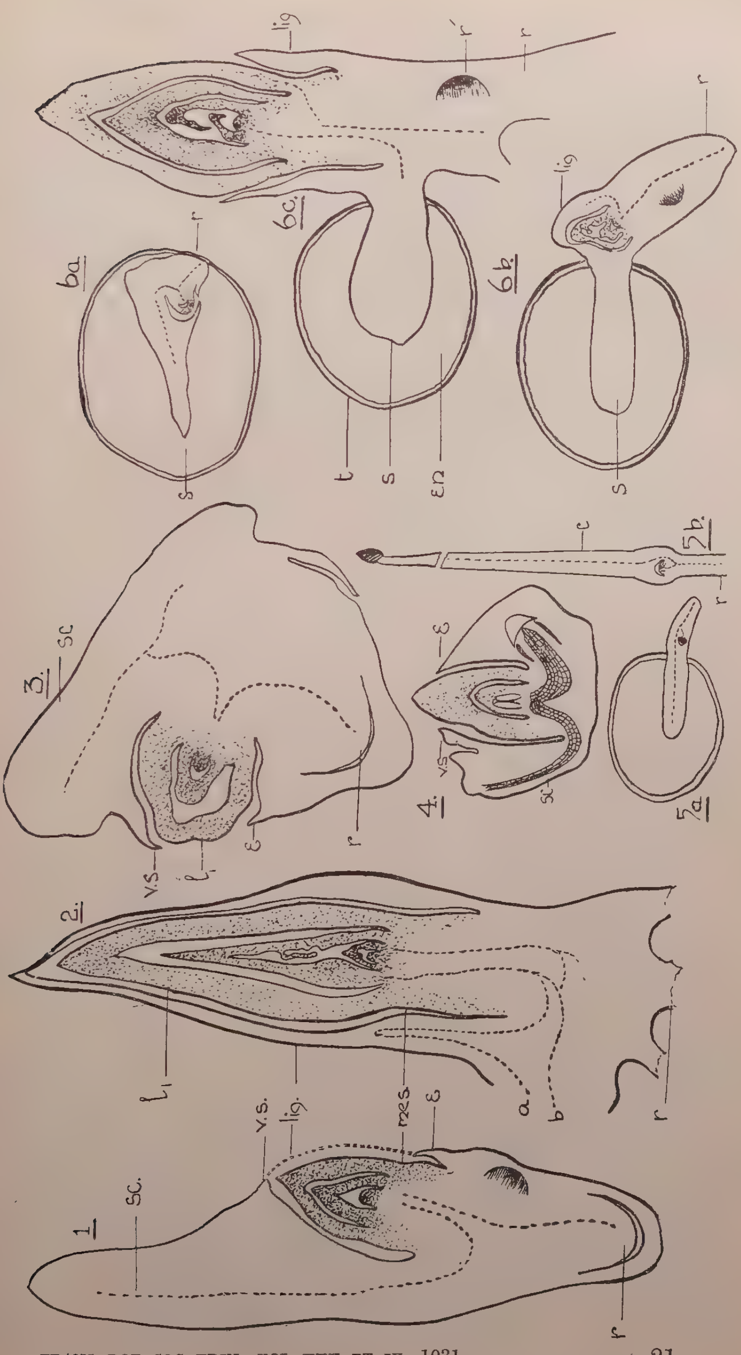

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FIG. 2.

Where the cotyledon is ligulate, however, the vertical line in which plumule and radicle lie is at right angles to the cotyledon stalk and sucker (fig. 2, 6*c*). This orientation reacts upon the intra-seminal condition. Not only are the plumule and radicle out of alignment with the remainder of the embryo, but they lie at an obtuse angle to each other (fig. 2, 6*a*). The form of the post-seminal plant appears to be foreshadowed in the seed.

The culmination of all these tendencies is to be found in the Grass Embryo and Seedling.

PREVIOUS HISTORY OF RESEARCH ON THE GRASS EMBRYO.

The grass embryo has been so often described that another account of it would be superfluous. The opinions of different investigators on the organs in dispute will, however, be summarised.

(i) *The Scutellum.*—This fleshy, shield-like structure (fig. 2, 1) is now commonly admitted to be a haustorial organ, the equivalent of the suctorial part of the cotyledon. It has been interpreted at different times as an absorptive organ, as the tegument of the endosperm, as a haustorial organ, not, however, morphologically equivalent to the cotyledon, or as part of the single cotyledon of which the remaining portion is the coleoptile.

(ii) The term *coleoptile* designates the sheath of the plumule. It has been regarded as the single cotyledon or its expanded part. Schleiden (16) supposed it a primordial leaf succeeding the cotyledon; Van Tieghem (18) believed it to originate from the union of a pair of stipules belonging to the cotyledon proper, represented by the scutellum, while Schlickum considered it exactly comparable to the ligule of the cotyledon as seen in other monocotyledons.

(iii) *The Epiblast* is a parenchymatous, non-vascular, leaf-like structure, which, if present, arises opposite to the scutellum. It has been described as a rudimentary second cotyledon, as a prolongation of the scutellum, as part of the cotyledon sheath, or, since it possesses a downward extension, part of the coleorhiza or sheath of the primary root. Celakovsky (3) compares the cotyledon to the adult foliage leaf of the grasses, the epiblast being equivalent therefore to a pair of fused auricles.

(iv) *The Mesocotyl.*—The strongest argument against the ligulate nature of the coleoptile is that in certain genera a region produced by intercalary growth separates what is regarded as the two parts of the cotyledon, namely, scutellum and ligule. To this intercalary portion the term mesocotyl was therefore applied. Further, it is traversed by cotyledonary and plumular strands.

Its significance is a matter of more recent discussion. Van Tieghem, by a "bold morphological fiction" (18, p. 164), described it as a lengthened node. Celakovsky, arguing from developmental evidence, held the same view, while Bruns (2), basing his theory entirely on external appearances, regarded it as the first internode of the plumular axis, an opinion revived within recent years by Coulter (4). The latter, whose views were coloured by his findings in an anatomical investigation of a dicotylous *Agapanthus*, demonstrated that in grasses a remarkable number of transition stages from dicotyledony to monocotyledony were to be found. The epiblast, then, represented a second cotyledon; the mesocotyl between the two "cotyledons" was therefore the first internode of the plumule. Coulter's conclusions were criticised by Worsdell on two grounds, namely, that they were based on external morphology and with an entire disregard for previous publications on mesocotylar anatomy. Worsdell's own theory, which was founded on a comparative morphological treatment of the seed leaf and the adult foliage leaf, does not account satisfactorily for the vascular structure of the mesocotyl.

Sargant and Arber's Memoir of 1915 (15) proposed a theory commonly accepted as being in accord with the anatomical facts. From a consideration of a series of ligulate seedlings, the idea was conceived of the cotyledon stalk becoming so closely adpressed to the sheath that finally a fusion, affecting the cotyledon stalk and hypocotyl, occurred. The resulting structure, the mesocotyl, was therefore partially cotyledonary in its nature.

The investigators in this instance were led to a theory by the anatomical resemblance between the coleoptile and the typical ligule of the monocotyledonous seedling. The facts concerning the mesocotyl were made to fit a theory which would allow the coleoptile, with its two strands derived from the cotyledon, to be homologous with such a ligule. The theory would seem to suffer from other defects. It rested on somewhat insufficient evidence. A very thorough research was made on numerous grass seedlings, but the theory was founded chiefly on the vascular skeleton of six genera of Zingiberaceae. In four of these the two cotyledon strands entered the ligule, but in *Alpinia* the upper bundle, *when* it entered the sheath, only penetrated it for a short distance, and in *Brachychilum* the ligule contained no bundles whatever. The exact course of the strands which did not enter the ligule in *Alpinia* and *Brachychilum* was not fully described. The fact that the ligule of the latter could be non-vascular ought possibly to have been disadvantageous to its use as evidence for the nature of the two-stranded coleoptile: no such objection seems to have been raised. The theory lacked simplicity to a certain degree. Explanations of certain structures had to be made, often with difficulty, for the sake of conformity with the theory, while it left the nature and variability of the epiblast unexplained. Howarth, in 1927, found confirmation of Sargant and Arber's theory in his research on *Festuca rubra* (12).

Percival (13) believes that scutellum, epiblast, coleoptile, and first green leaf of the grass seedling are the first four leaves of the plant. He makes no attempt to reconcile the anatomical facts with this view and fails to appreciate what Sargant so clearly demonstrated—that the key to the interpretation of the grass embryo was to be found, not in itself, but in the structure of a seedling, the nature of whose organs was in no way obscure.

The Grass Embryo as a Final Stage in an Evolutionary Sequence.

Orientation of Organs in the Embryo.—The germination of a typical ligulate seedling exhibits two phases. In the first, the embryo elongates and emerges without cell division, the axis of the plumule lying at an obtuse angle to that of the radicle: this phase may be regarded as the completion of the maturation of the embryo (fig. 2, 6*a*, 6*b*). The final orientation of the organs of such a seedling occurs in the second phase, three or more days later, when the axes of radicle and plumule lie in a vertical straight line (fig. 2, 6c), which is at right angles to the suctorial portion of the cotyledon enclosed in the seed. Differentiation has proceeded so far before germination in many genera of the Gramineae that the first phase does not occur; the parts of the embryo have already changed to the relative positions of the second phase, and a stage in development normally occurring post-seminally is attained within the seed (fig. 1, vi). These observations on the orientation of the embryonic organs were previously made by Gatin (6, 7), whose work on seedling anatomy has been almost entirely ignored by later investigators. He apparently recognised neither the significance of his findings, nor the fact that the grass embryo repeats in its intra-seminal ontogeny the sequence followed in the early post-seminal development of ligulate seedlings belonging to other monocotyledonous orders.

Relative Development of Organs in the Embryo.—The remarkable development in the grass embryo of the plumule and the adventitious root system, taken in conjunction with the pronounced endogeny and poor differentiation of the radicle, is in accordance with the opinion that it belongs to an advanced type. The cotyledon affords striking evidence of this view. Reduction has affected it to such an extent that it now consists of

(i) a suctorial portion, the "scutellum," and, in certain species,

(ii) a fragment of the sheathing base, hitherto termed the epiblast.

The cotyledon is entirely non-vascular except for the scutellum traces. Its strands have become part of the vascular system of the first internode of the plumular axis, the so-called mesocotyl. The cotyledon possesses no distinct organ that can be termed a ligule: the "coleoptile" is therefore the first plumular leaf. The basis for this view is revealed by a comparison of certain grass seedlings, described by Sargant and Arber, with seedlings of *Billbergia zebrina* (Bromeliaceae) and of two genera of Zingiberaceae, namely, *Hedychium Gardnerianum* and *Alpinia calcarata*. The three genera have seedlings of the ligulate type. It is not proposed in this paper to describe fully the phenomena of germination and the external morphology of these seedlings. An account is given of the anatomy only in so far as it has a bearing on the elucidation of the problem of the grass embryo.

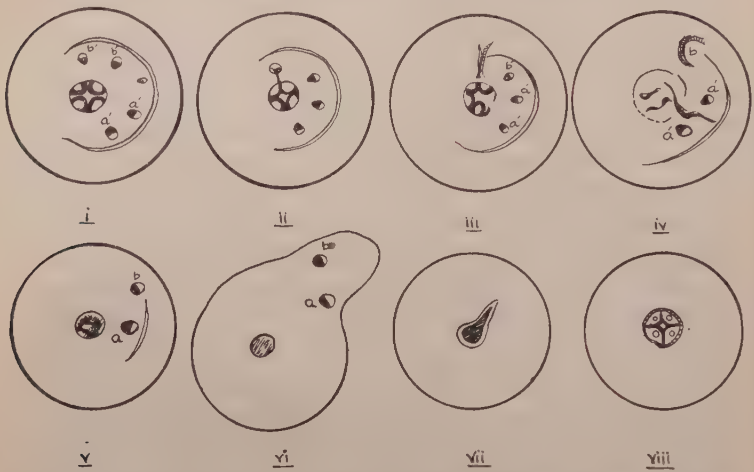

Fig. 3.—*Alpinia calcarata.* Series of transverse sections through seedling two days old. viii. Primary root. vi. Two cotyledon strands proceeding through the stalk. iv. Strand *a* branches, giving two strands, *a′*, to the first leaf, the remainder being directed inwards to the meristem of the second leaf. i. Base of the first leaf, of which the total vascular tissue is derived from the greater part of the cotyledon strands.

Comparison of Certain Ligulate Seedlings with Types of Grass Embryo.

A. *Alpinia calcarata* (fig. 3).	*Sorghum vulgare.*
1. Two strands leave the suctorial tip of the cotyledon, proceed through stalk, and at the base of plumular axis each ramifies, giving three traces (fig. 3, iv).	1. A single strand proceeds from the "scutellum" straight to the base of the "mesocotyl."
2. The axis has a central core consisting of plumular traces plus one-third of each cotyledon strand. The latter supply the second leaf. An outer ring of four strands derived from the cotyledon supplies the first leaf (fig. 3, i).	2. The stele of the "Mesocotyl" consists of two "coleoptile" traces (distinctly double) plus plumular traces. Part of the scutellum trace forms half of each coleoptile trace at the top of mesocotyl. The remainder is prolonged downwards towards the root.
3. The first leaf derives its total vascular supply from the cotyledon strands.	3. The "coleoptile" (*i.e.* first leaf) derives its total vascular tissue from the cotyledon.

B. *Billbergia zebrina* (fig. 4).	*Avena sativa.*
1. A single cotyledon strand proceeds from the tip, through the stalk (fig. 4, vii).	1. There is a single scutellum trace.
2. It ascends the first internode in an independent peripheral position (fig. 4, iv).	2. It ascends the "mesocotyl" as an independent peripheral strand.
3. Towards the top it merges into the meristem of the first leaf, contributing to the lateral strands (fig. 4, i).	3. At the top of the mesocotyl it forms part of the complex from which the two "coleoptile" strands, laterals of the "first" leaf and mid-rib of the "second" leaf, arise.
4. Longitudinal sections reveal the presence of a bridge comparable to that in Avena.	4. The top of the scutellum trace is connected to the central stele by a xylem "bridge" or "arch."
C. *Hedychium Gardnerianum* (fig. 5).	
1. Two strands are found in the cotyledon tip. 2. *One* strand proceeds horizontally to base of plumular axis, where it divides— i. half maintains an independent peripheral position to the top of the internode, where it merges into the meristem of the lateral strands of the first leaf and the mid-rib of second leaf ; ii. half enters the central stele of the axis. 3. The first leaf laterals and possibly the mid-rib of the second leaf are derived from half of the cotyledonary tissue.	Represents a compromise between *Avena* and *Sorghum* in the occurrence (*a*) of an independent peripheral scutellum trace ; (*b*) of a portion of the scutellum trace becoming part of the central axis of the first internode.

Conclusions drawn from above Comparison.

1. The occurrence of cotyledon traces, independent or otherwise, in the first internode of the plumular axis is a feature that can no longer be associated with Gramineae alone. The need for a hypothetical mesocotyl in the grasses does not therefore exist.

2. Leaf-like organs drawing their vascular supply wholly or partly from the cotyledon are not necessarily to be regarded as cotyledonary in nature. The plumular origin of the first foliar member of *Alpinia calcarata*, which exactly homologises with the "coleoptile," is indisputable.

3. The grass seedling has now no "ligule," but its cotyledon

was formerly identical with that of the *Hedychium* type, consisting chiefly of ligule, with the stalk inserted so low that almost no sheathing base was present.

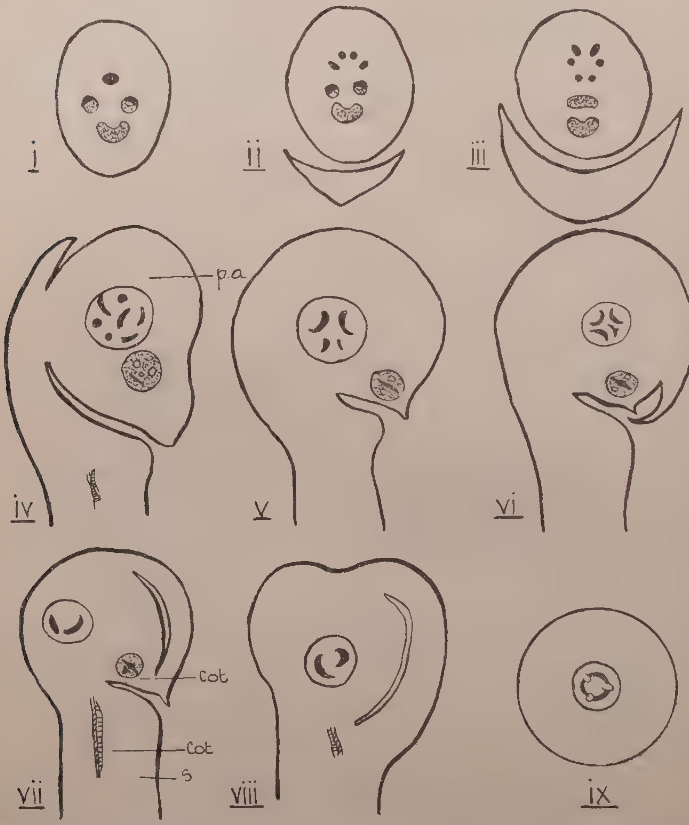

FIG. 4.—*Billbergia zebrina.* Series of transverse sections through young seedling. ix. Primary root. iv–viii. Cotyledon strand (*cot.*) proceeds through the short stalk (*c.s.*) and enters the plumular axis. i. Axis towards base of the first leaf. (The cotyledon strand may bend upwards in passing to the axis, hence it may appear twice in the same transverse section.)

Derivation of the Grass Cotyledon from that of the Hedychium Type.

1. Tangential pressure on the club-shaped sucker of *Hedychium* will produce the fleshy plate (scutellum) of the grass.

2. As a result of the same force the short stalk (almost non-existent) in *Hedychium* will completely disappear.

3. If, in *Hedychium*, that side of the ligule remote from the sucker becomes thinner, until finally in the weakest region the tissue ceases to develop, only a fragment (the epiblast) will persist on one side. The other side of the ligule will be contiguous with the sucker, with which it will, therefore, fuse. The plasticity of the latter will be advantageous for this union.

Evidence for such a derivation of the grass cotyledon is found in that organ itself.

(i) *The Epiblast* may be non-existent (*Zea*), a thin scale barely discernible, or a leaf-like organ clasping half round the "mesocotyl" and having its tip extended to the level of the base of the coleoptile (*Zizania aquatica*). In extreme cases (*Leersia clandestina*) the epiblast may reach almost to the tip of the coleoptile. Reduction has therefore progressed to varying degrees in the different genera. Van Teighem's research indicates that two-thirds of the grasses have an epiblast, while Bruns's tables on the frequency with which it occurs reveal an interesting sequence. With the exception of the *Oryzeae*, tribes of Hackel's first series have, as a rule, embryos with no epiblast. It is found with very few exceptions in the remaining tribes. These comprise Hackel's second series, which, according to Bews (1), contains most primitive forms. *Hordeum* and *Triticum* at the end of the second series have two strands in the cotyledon and an epiblast. The relatively advanced *Zea Mays* at the beginning of the first series has no epiblast, and only one vascular strand: it thus appears as the final stage in the gradual loss of the ligule and reduction of vascular tissue.

(ii) In certain instances the orientation of the ripe embryo is only slightly in advance of that of the *Hedychium* type. Epiblast and scutellum are then of equal length (giving an appearance which misled Coulter to a discovery of "dicotyledony"). A bridging of the short gap between them would complete the ligule (fig. 2).

It is interesting to note that stages comparable to this occur in the early ontogeny of the advanced types. Further differentiation and growth of the embryo result in a widening of the distance between the two parts of the cotyledon.

(iii) The remainder of the non-vascular ligule, in fusing with the flat sucker, lost its identity almost completely. An indication of its former separate existence is given by the short overhanging protuberance at the upper limit of the scutellum, sometimes designated " the ventral scale." (Percival, regarding the scutellum as a foliage leaf, terms it " the ligular scale.") Like the epiblast, its development is variable. It is very marked in the floristically primitive *Bambusa*, a genus of which the embryo is ontogenetically backward (fig. 2). In embryos with large epiblasts it seems to be prominent, but frequently does not appear where the former is missing. A very significant figure of an immature embryo of *Oryza sativa* by Bruns shows a deep cleft occurring between the outer layer of the scutellum and the lengthy protuberance (fig. 2). The ventral scale evidently represents the apex and often, in addition, part of the aborted portion of the former ligule, which is now limited to the epiblast and to the inner layer of the scutellum. The outer layer of the latter was the sucker ; it includes the vascular tissue and is bounded by the epithelium. The sucker in its original form may not have been necessarily club-shaped as in *Hedychium*. *Musa*, for example, has a sucker shaped like a plate.

Probable Factors in Determining the Configuration of the Cotyledon.

1. A balance is maintained between the embryonic organs. Inordinate development of the plumule seems to have an effect on the radicle. It may in addition react adversely on the cotyledon.

2. The mature embryo represents a phase which in other monocotyledons takes place post-seminally. Unlimited expansion would normally be available. The firm pericarp and mass of endosperm place restrictions upon a body in a plastic condition, and were probably the most potent factors in altering the shape of the cotyledon. As would be supposed, distortion from the normal *Hedychium* type is least in the very early stages.

3. The position of the embryo in the seed accounts for its shape. Subjected to pressure from the endosperm side, the organs most affected will be

(i) the sucker and the half of the ligule on that side :

(ii) the portion of the ligule forced against the testa. The lack of endosperm in this neighbourhood and the downward extension of the epiblast in certain embryos are thereby explained.

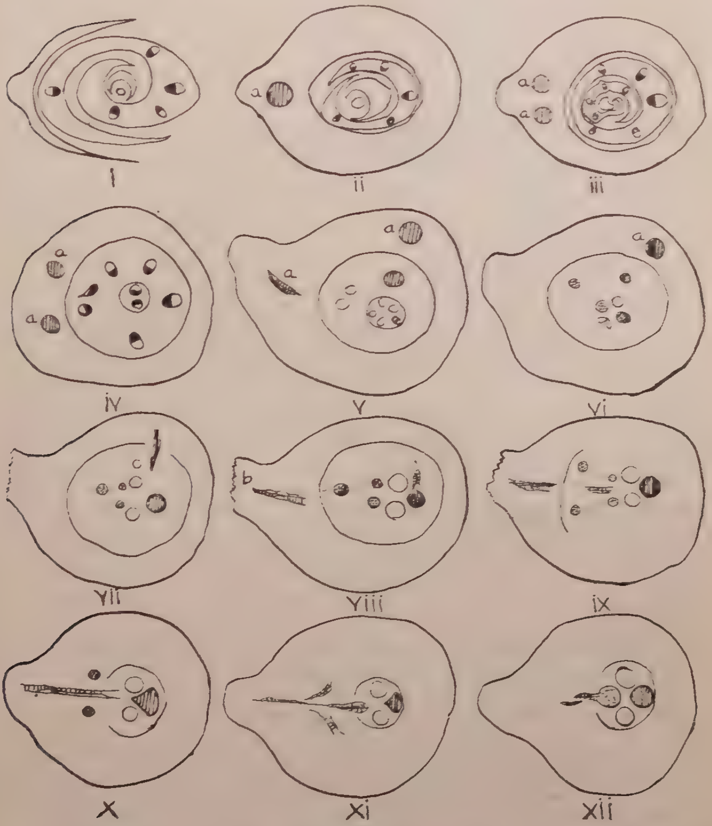

Fig. 5.—*Hedychium Gardnerianum*. Transverse section of seedling six days old from hypocotyl to the plumular bud. i. Plumular bud and tip of ligule. ii. Tip of cotyledon strand *a* where it bends downwards (see fig. 2, 2). iii. Upward and downward traces of strand *a* passing through the ligule. v. Strand *a* proceeds through the stalk of the cotyledon towards the sucker. vii. The other end of strand *a* as an independent trace ; it now enters the plumular axis. viii. Strand *b* proceeds outwards from the seed through the stalk. ix–xii. Strand *b* enters the axis. xii. Upper limit of hypocotyl. The four groups of vascular tissue rearrange themselves to supply a tetrarch stele in the primary root.

The apex of the radicle and of the ligule will be least affected.

The vestigial remains of the latter have therefore persisted as "the ventral scale."

The coleorhiza does not merit a discussion; its existence is clearly the result of the endogeny of the radicle.

Possible Criticisms of the Foregoing Argument.

(i) That the venation of the coleoptile is inconsistent with that of an independent plumular leaf. (Used by Worsdell of Coulter's Theory.)

> The first scale leaf of *Romulea ramiflora* (Iridaceae) and the coleoptile are identical in venation.

(ii) That there exists a greater difference between the coleoptile and the "first leaf" than between the latter and succeeding leaves. (Worsdell criticising Coulter.)

> This argument is refuted by observations on monocotyledonous seedlings over a sufficiently wide field. The first foliar organ has frequently a shape and venation simpler than for succeeding leaves, while certain groups, *e.g.* the Zingiberoideae, provide excellent examples of second and third plumular leaves being also of the nature of scale leaves.

(iii) That Hegelmaier and Hanstein observed that "the rudiments of the coleoptile arise in the tissue complex which is becoming the scutellum." (Worsdell.)

> In a similar manner the first leaf of any monocotylous embryo would appear to arise from the surrounding cotyledon tissue. The distortion in the plumular region of the embryo, and the lack of cotyledonary tissue to sheathe the bud, has obscured the true origin and nature of the "coleoptile."

(iv) That no instance can be cited in which the gap between the epiblast and the ventral scale is actually bridged.

> A line of future research is suggested by this criticism. The search for an embryo showing such a fusion may be fruitless since the gap in the ligule possibly corresponds to a slit such as occurs in numerous cotyledons for the emergence of the first leaf.

The Position of the Present Theory in Relation to Previous Interpretations of the Grass Embryo.

1. In its conception of the nature of mesocotyl and coleoptile, it is akin to that of Bruns and Coulter, but the latter accepted the plumular nature of these organs as a corollary to their belief that the epiblast was a second cotyledon and not on anatomical grounds.

2. It accounts in a consistent manner for the epiblast and ventral scale where these occur, and for their absence in the advanced types. That the epiblast is a scutellar outgrowth (3) or foliar organ such as occurs at the base of the axis of *Sedum* (Celakovsky) is incompatible with its position, which would inhibit the production of new structures.

3. The difficulties which had to be explained away by Sargant and Arber on their assumptions no longer arise; for example, the anatomical difference between the " mesocotyl " of *Sorghum* and *Avena*, the absence of mesocotyl in *Hordeum* and *Triticum*, and the " xylem arch " at the top of the mesocotyl in *Avena*. The bud axillary to the coleoptile which Howarth found in *Festuca rubra* no longer calls for comment: it is merely in the axil of a plumular leaf.

4. The necessity for the phylogenetic relationship between *Zingiberaceae* and *Gramineae*, suggested by Sargant and Arber (15, p. 219), to explain similarity in seedling structure, does not exist, since the Grass type of " mesocotylar " anatomy occurs in *Bromeliaceae* as well as in *Zingiberaceae*. A more striking example of parallel development would be difficult to find.

5. The grass embryo regarded from the new standpoint is in closer conformity with the general monocotyledonous type than hitherto.

SUMMARY.

1. A brief survey of apparent evolutionary trends in the seedlings of monocotyledons indicates that the main tendency is towards precocious development of the plumule, abortion of the radicle, and consequent importance of an early adventitious root system. The vascular tissue of the cotyledon is disappearing, a phenomenon illustrative of convergent

evolution, since it is found in families which differ widely in phylogeny. Such trends are included in the possible factors which have determined the configuration of the grass embryo.

2. An historical account of previous views on the morphology of the embryo and seedling in the Gramineae is followed by a comparison of certain types of grass embryo, described by Sargant and Arber, with seedlings of three genera investigated by the writer.

3. A new theory having for its basis the anatomical evidence provided by the latter seedlings places the following interpretation on those organs of the grass embryo at present in dispute :

The *scutellum* is a double structure consisting of (i) a vascular plate bounded by the epithelium and equivalent to the suctorial tip, in contiguity with (ii) an inner non-vascular plate which is adpressed to the embryonic plumular organs and is equivalent to part of the cotyledonary ligule.

The *epiblast* is a fragment of the sheathing base of the cotyledon and of that side of the ligule which has disappeared.

The *ventral scale* is the vestigial remnant of the apex of the ligule of the cotyledon.

The *mesocotyl* is the internode separating cotyledon and first leaf. Its origin and nature are purely plumular, though its vascular tissue may at first be wholly or partially derived from the cotyledon. The term "mesocotyl" is not only unnecessary but misleading.

The *coleoptile*, like the mesocotyl, is a plumular organ, and is equivalent to the first foliage leaf : it is a scale leaf in its appearance. The so-called "first leaf" is actually the second plumular leaf of the seedling.

4. Further evidence for the theory, possible criticisms of it, and its position in relation to the opinions of previous investigators are then discussed.

The writer wishes to acknowledge her indebtedness to Professor W. Wright Smith, Regius Keeper of the Royal Botanic Garden, Edinburgh, for facilities for the present study, and to his University and Garden staff.

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A complete list, in chronological order, of the principal papers on the embryo and seedling of the Gramineae will be found in the bibliography of Sargant and Arber (15) and Worsdell (19).

NOTES ON SALT-MARSH PLANTS. I. GLAUX MARITIMA LINN.

By MARGARET A. MOIR, B.Sc.

(Read 18th June 1931.)

Glaux maritima L. is a small succulent herbaceous perennial of sub-prostrate habit. It is common on salt marshes and other parts of the seashore on British coasts, and is found in habitats which differ widely in their edaphic factors. The hydrogen ion concentration of the soil varies very little, being between 6·7 and 7·1, rather more acid than alkaline; on the other hand, the water-content and physical nature of the soil vary considerably. Plants were examined from dry sandy soil on the cliffs; also from salt- and fresh-water marshes near the Eden estuary, where the soil was heavy clay and humus, and the water-content very high.

It was found that, correlated with the variations in the habitat, there are variations in the external morphology, and in the fertility of the plants. Those in the marshes show a much greater luxuriance of vegetative growth, and at the same time they flower scantily and set very little seed; while those in the drier habitats show a condensed growth form, and flower freely and set a large quantity of seed.

The phyllotaxy is normally cyclic, but tends to become irregularly spiral where rapid growth occurs; this tendency is especially noticeable in the marsh plants.

LEAF STRUCTURE.

The leaves are of two kinds, colourless kataphylls and green assimilatory leaves. In the former the mesophyll is undifferentiated and there is a central unbranched meristele; in the latter the venation is pinnate-reticulate, and the mesophyll is differentiated into palisade and spongy tissues, of which the former predominates, especially in the more apical leaves which show a tendency to the centric type of structure.

Irregular striations of the cuticle were observed, such as are recorded by Decrock ((1), p. 61), as a characteristic feature of the family Primulaceae. No apical hydathode pore as described by Decrock (*loc. cit.*, p. 65) for the family was found in this type.

Stomata occur on both surfaces of the green leaf, being approximately one and a half times as numerous on the lower as on the upper surface. They are more sparsely distributed on the stem, and occur only rarely on the kataphylls. In the green leaves the guard cells are very small in comparison with the epidermal cells, and are slightly raised above them (fig. 1, *a*). The external walls have cutinised projections which meet above the stoma and protect it. The guard cells on the kataphylls are larger, and are just appreciably depressed below the level of the epidermis (fig. 1, *b*).

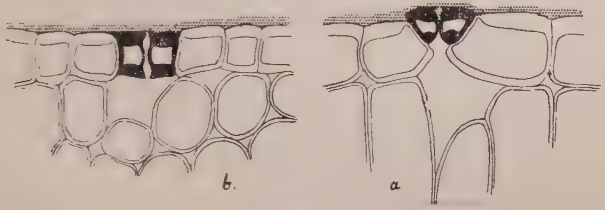

FIG. 1.

a. Transverse section through a stoma on the adaxial surface of a green leaf (× 300).
b. Transverse section through a stoma on the adaxial surface of a kataphyll (× 300).

Capitate glandular hairs, which, according to Solereder ((2), p. 503), produce a resinous secretion below the cuticle, occur on both surfaces of the leaf, more rarely on the kataphylls, and very rarely on the stem. Each hair consists of a basal cell, a stalk cell, and a head of four or more cells with prominent nuclei. On young organs the stalk and head of the hairs project; but when fully developed the hair is so deeply sunk in a depression that the head is below the surface (fig. 2, *a*, *b*, *c*).

In 1904, Zalensky formulated a new conception of xeromorphy in his quantitative anatomical investigations of different leaves of the same plant; later his work was independently confirmed by Yapp and others. The results of their work was to establish a general rule that the anatomical structure of individual leaves of one and the same shoot is a function of their distance from the root system; and the higher a leaf is inserted on a stem, the more xeromorphic is its structure ((3), pp. 328--336). In order to ascertain how far the leaves of *Glaux maritima* conformed to Zalensky's hypothesis, several series of leaves, taken from different levels on the stem, were examined and measured. It was found that in comparison with a leaf near the base of a stem, a leaf higher up near the apex has, in *Glaux maritima*,

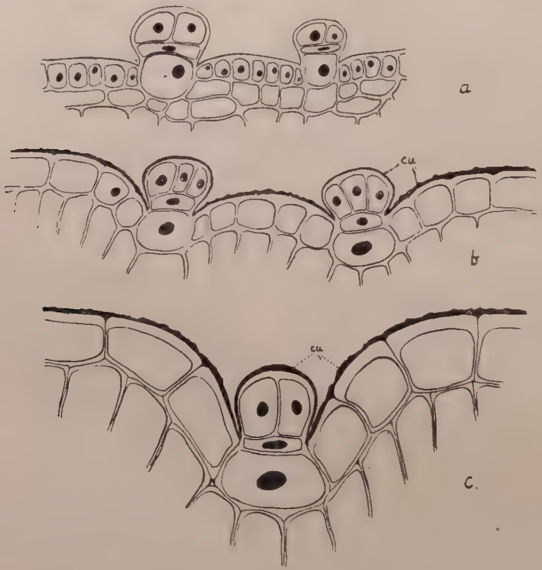

FIG. 2.

a. Part of a transverse section of a young leaf, showing hairs projecting from the surface (× 300).
b. An older stage of the same (× 300).
c. Part of a transverse section of an adult leaf, showing one hair fully developed and sunk in a deep depression (× 300). cu=cuticle.

(1) smaller cells throughout the leaf ;
(2) a larger proportion of palisade tissue (to such an extent that there is a tendency to the formation of palisade cells on the abaxial surface at the edges of the leaf) ;
(3) a smaller proportion of spongy tissue ;
(4) a thicker epidermis, the cells being deeper ;
(5) thicker external walls of the epidermal cells ;
(6) smaller stomata and more per unit area of leaf surface ;
(7) smaller epidermal hairs and more per unit area of leaf surface ;

(8) increased sinuosity of the epidermal cell walls ;

(9) to a variable extent, increased density of venation, but this is not entirely constant throughout the series (fig. 3, *a*, *b*, *c*, *d*).

These results, with one exception, agree with those obtained by Zalensky, the exception being the increase in sinuosity of the epidermal cell walls, Zalensky having recorded a progressive decrease in sinuosity from lower to higher.

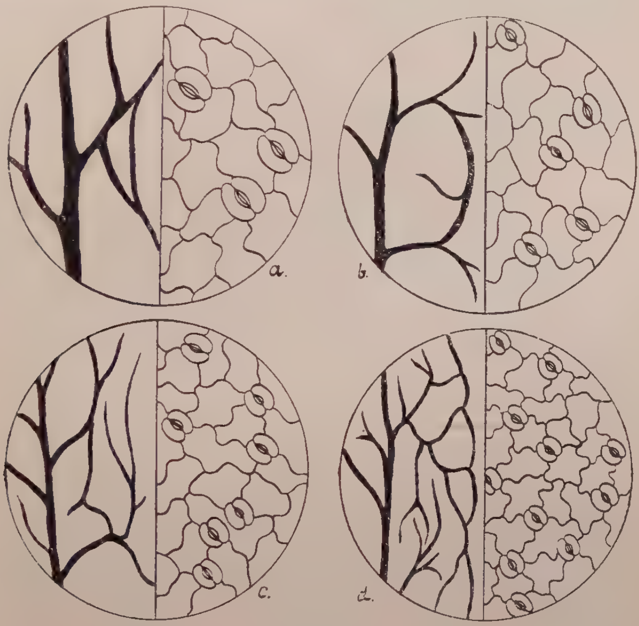

FIG. 3.

a. Diagram of the venation and epidermis of a leaf from a node near the base of the stem (venation ×55 ; epidermis ×270).
b. The same of a leaf four nodes higher.
c. The same of a leaf eight nodes higher.
d. The same of a leaf twelve nodes higher.

STEM STRUCTURE.

The stem is green, smooth, and oval in section ; the direction of the long axis of the oval turns through a right angle at successive nodes, due to the passing out of the pairs of leaf traces (fig. 4). Throughout the internodes the outline of the stem retains two longitudinal grooves, correlated with the deep impression made by the axillary buds at the node below. In length the stem varies from two to fifteen inches according to the habitat; the kataphyllary hypogeal region measures three-eighths of the whole. The procumbent tendency of the shoots leads to dorsiventrality, due to torsion of the leaves and secondary lateral branches.

Both outer and inner walls of the epidermis are thickened; there is a deep cortex of chlorophyllous cells which are elongated longitudinally. In the outer and middle cortex large intercellular spaces form continuous longitudinal air channels, which are interrupted at the nodes by nodal diaphragms several cells deep. A ring of sclerenchyma is developed round the stele by the lignification of the pericycle. Of eight primary collateral vascular bundles four are foliar and four are cauline. Secondary development of phloem is initiated very early, the phloem forming a continuous ring, while the eight xylem bundles remain quite distinct from each other; later a certain amount of secondary xylem is formed. In young stems the xylem parenchyma is chlorophyllous.

The stolons are similar in structure except that the intercellular channels are smaller. The stem apex is stratified; in the plerome there is a large central cell which is considered by Decrock to be the primary mother cell of the plerome. In the leaf primordia a similar large cell gives rise to both periblem and plerome (fig. 5).

Root Structure.

The root system of the adult plant is adventitious; the point of origin of the roots is definite and regular, they are developed from the stem just below a node, and they emerge on either side of the leaves. Four latent root primordia are present at every node; in a transverse section of the stem they appear as a diagonal cross, the arms of which radiate out from the stele (fig. 6).

The internodes at the base of the stem are much condensed, and at each of the three lowest nodes two or more of the root primordia remain latent; those which develop give rise to four or five long fleshy roots, which penetrate the soil to a maximum depth of nine inches, and are the main roots of the plant.

At the other nodes on the lower parts of the stem, and on

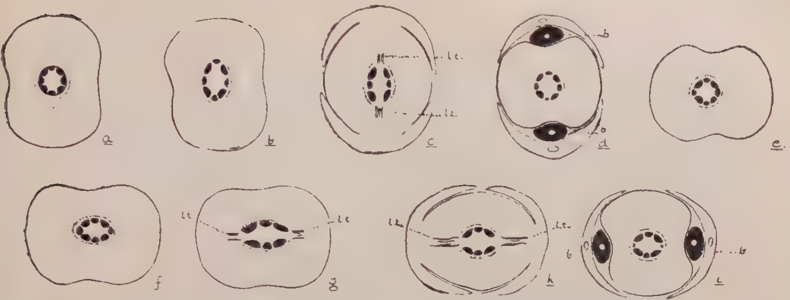

FIG. 4.—Diagrams of transverse sections of the stem, showing the changes in outline at successive nodes. l.t. = leaf trace; b = bud.

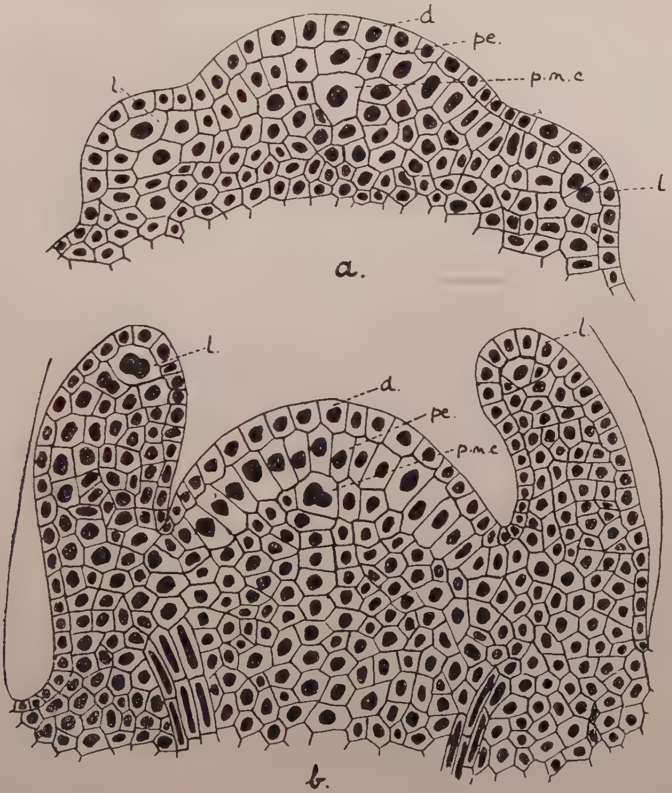

FIG. 5.

a. Median longitudinal section of the apex of the stem, showing young leaf primordia (× 480).

b. Median longitudinal section of the apex of the stem, showing older leaf primordia and the clearly stratified apical meristem tissues (× 480). pe = periblem; d = dermatogen; p.m.c. = primary mother cell of the plerome; l = primary mother cell of the periblem and plerome of the leaf.

the stolons, all the primordia usually develop, resulting in four delicate roots per node. It was found that by further submerging young plants in soil or water, it was possible to induce the development of these roots as high up as the fifth node from the apical bud. Cuttings of young shoots rooted readily, but produced the short thin type of root only.

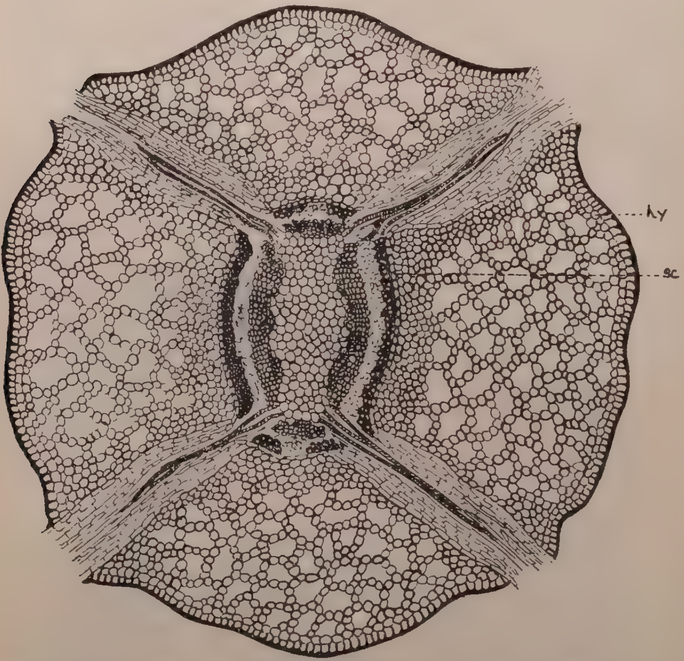

FIG. 6.—Transverse section of the stem near the base, just below a node, showing the origin of the four adventitious roots (× 32).

The exodermis is double, both layers being suberised ; the cortex is very large in proportion to the stele, the inner cortical layers being slightly affected by the suberisation of the endodermis. The primary stele of the main roots is pentarch, that of the smaller roots triarch, and of the lateral roots diarch. Secondary development of the stele is not accompanied by development of secondary cortex ; the outer layers of the existing cortex become collenchyma. The root apex shows a normal stratified meristem ; there is a large conical root cap (fig. 7).

Vegetative propagation and perennation is effected by hypogeal stolons, which are developed very early on young plants, and arise in the axils of kataphylls near the base of the main stem. In late summer large specialised hypogeal buds are formed on these stolons at intervals of four internodes. One of the two axillary buds at a node increases in size, develops three or four strong roots, and becomes filled with starch reserves in the form of both simple and compound grains. These are present throughout the cortex of the roots, in the cortical and medullary cells of the axis, and in the mesophyll of the kataphylls. Normally the outer bud remains dormant, but rarely both may develop in this way. When fully formed they are half to one inch long and pinkish in colour, due to anthocyanin in the subepidermal layers on the abaxial surface of the kataphylls.

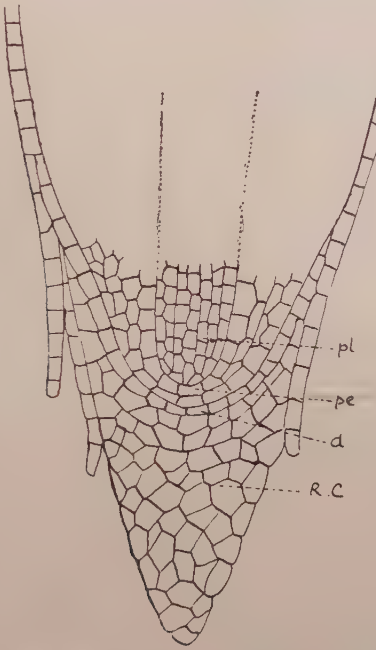

FIG. 7.—Median longitudinal section of the apex of the root (× 160). pl = plerome ; pe = periblem ; d = dermatogen ; RC = root cap.

In autumn the entire plant dies down, the stolons decay, leaving the buds free in the soil, where they remain dormant as the perennating organs of the plant.

Growth in spring begins by the development of lateral roots, which is followed by the elongation of the axis and the exposure of the apex to light. At this stage the buds contain a high concentration of anthocyanin. Under the influence of light there is a gradual transition from kataphylls to green assimilating leaves, and by early lateral branching near the ground-level the bushy character of the plant is again attained.

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NOTES ON SALT-MARSH PLANTS. II. PLANTAGO MARITIMA LINN. By DAVID F. STEWART, B.Sc.

(Read 18th June 1931.)

Material was collected from six different stations:

A. The seaward side of a Salt-Marsh Community, where the plants are submerged daily.

B. The extreme landward side of the same community.

C. A "Fresh-Salt Marsh" where the water is intermittently fresh.

D and E were in the Cliff Community.

F. The seaward side of the Cliff Community.

The climatic conditions and nature of the substrate vary, the latter from pure clay with about 5 per cent. humus, to an equal mixture of clay and humus, to a mixture of sand, humus, and about 5 per cent. clay, to a mixture of sand, silt, and humus, to pure sand with about 5 per cent. humus.

The pH varies from 6·5 to 8·8.

In general, it was found that the more sheltered a plant is, the bigger are the dimensions of the vegetative organs, *e.g.* the lamina of the most sheltered plant (Station B) was five times longer and four times broader than that of the most exposed plant (Station F). The rootstock was 7·1 times longer and 1·3 times broader. But occasionally there are divergences, *e.g.* one plant was more sheltered than another, yet the lamina of this plant was only half as long as that of the other. This difference may be correlated with chemical soil differences, in which case it must be inferred that both edaphic and epidaphic factors are concerned in the moulding of the external configuration of both leaf and rootstock.

Other differences in the external morphology of plants from the various stations are:

1. Change in nature of the root system. In Stations A, B, and C the tap root is masked by the numerous adventitious roots. In the other three stations in the Cliff Community the converse is true.

2. The outline of the leaves may be linear or linear-oblanceolate.

3. The number of leaves per rootstock varies from five to eighteen.

4. The leaves may be oriented vertically or horizontally.

5. In each case the rootstock is multicipitate, but the number of branches varies from five to about one hundred.

The following external features are common to all leaves :—

1. A system of circular depressions, each containing one bicellular capitate hair, which may be a hydathode.

2. The stomata, more numerous on the upper than on the lower surface, are visible to the naked eye as minute white spots.

3. A system of unicellular or bicellular conical trichomes, which are covered by an epidermis continuous with that of the ordinary epidermal cell.

THE LEAF OF PLANTAGO MARITIMA WITH REFERENCE TO ZALENSKI'S HYPOTHESIS.

This hypothesis states that the higher the attachment of a leaf on a stem, the more numerous the stomata per unit area, and the stronger the relative development of venation ; also that the rate of increase of venation density is greater in plants of exposed than in plants of more sheltered habitats.

The problem in this work is to ascertain whether the hypothesis holds good from base to apex of a single leaf, although it must be remembered that uniform areas are not being considered.

Leaves from Stations F, A, and C were investigated in addition to leaves from a plant which had been transferred to the Botanical Gardens, St. Andrews, about ten years ago. The laminas of these leaves measured respectively, 5, 13, 13, 13 cm. in length. In the first case (Station F) preparations were made at points 0·5, 1·5, and 3·5 cm. from the apex ; in the next three cases at points 2·5, 6·5, 10·5 cm. from the apex.

In all twelve preparations a piece of upper epidermis was investigated for stomata, while the venation below that epidermis was considered. Care was taken that the venation, which is convergent striate reticulate, was examined between the two corresponding parallel mid ribs in each of the four leaves. Because of the succulence of the leaves, the veins are normally invisible to the naked eye. The method adopted to display the venation was to allow the leaves to soften for a day or two in water, and then, after peeling off a small piece of upper epidermis, to scrape carefully away the mesophyll tissue from above downwards. By means of Camera Lucida drawings (fig. 1, *a*, *b*, *c*), the exact number of stomata per unit area could be counted and the comparative length of veins could be measured in cm. The latter result was verified by counting the number of meshes between the veins. It was found that the number of stomata and length of venation per unit area progressively increased from base to apex (Table I.).

TABLE I.

Station	No. of Stomata from Base to Apex			Total	Length of Veins (in cm.) from Base to Apex			Total	No. of Meshes
Cliff	37	61	76	174	34	46	59	139	78
Garden	29	37	58	124	25	30	45	100	48
Salt Marsh	25 (Fig. 1*a*)	35 (1*b*)	39 (1*c*)	99	19 (Fig. 1*a*)	24 (1*b*)	43 (1*c*)	86	38
Fresh-Salt Marsh	18	27	38	83	13	29	45	87	40

Therefore, in each individual leaf Zalenski's hypothesis holds good, that is, the nearer the apex the greater the number of stomata per unit area and the stronger the relative development of venation. The following explanation has been offered. It has been proved that the intensity of transpiration of leaves developed in the sun is greater than those developed in the shade. In this case of a single leaf, the apex is developed later in the year, at a time when the atmosphere is less humid and the sun's rays are stronger. Therefore, the transpiration pull at the apex exceeds that at the base. Correlated with this difference in transpiration pull is the difference in the number of stomata and in venation density from base to apex.

The other part of the hypothesis, stating that the rate of increase of venation density on ascending the stem was greater in plants of exposed than in those of more sheltered habitats, does not hold for a single leaf from base to apex.

The question arose: Is the hypothesis applicable to a single leaf in different habitats, or do leaves in a dry atmosphere possess more stomata and a denser venation than those in a more humid atmosphere? The stations in order of greatest humidity are: C, A, Garden, and F. According to Zalenski, the order of stations with foliage possessing the greatest number of stomata and densest venation should be reversed. Studying Table I. vertically, this order is strictly true for stomatal distribution. There is one divergence in venation. It may be taken, therefore, that the hypothesis holds for entire leaves in different stations as well as for different levels of the

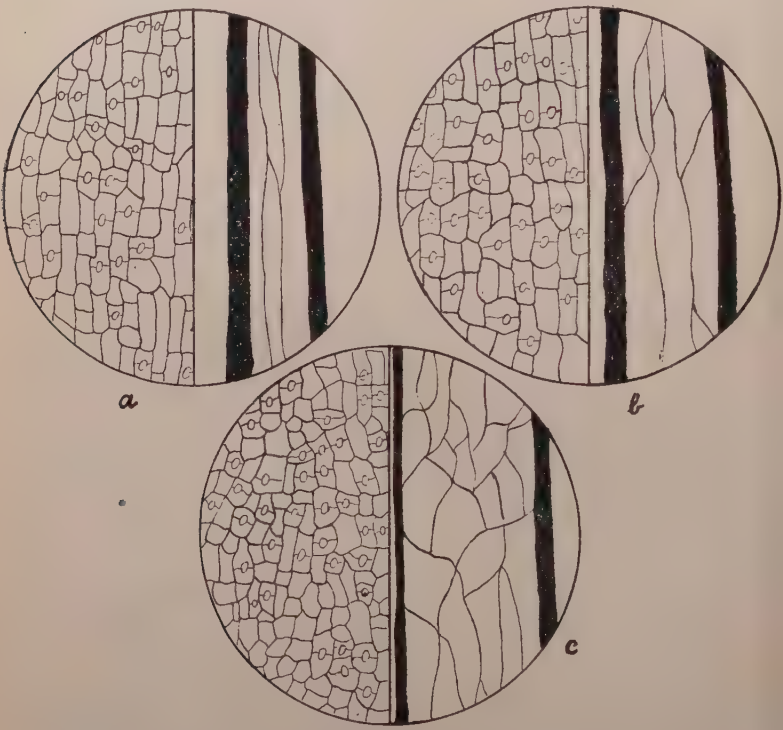

Fig. 1.—Number of stomata: *a*, 25; *b*, 35; *c*, 39 (×50). Length of veins: *a*, 19 cm.; *b*, 24 cm.; *c*, 43 cm. (×20).

same leaf. This conclusion is mainly based on stomatal distribution.

These results lend support to the view that the presence of sodium ions retards absorption. Although the exact contents were not ascertained, the Salt Marsh substrate must necessarily possess more sodium than that of the garden. In agreement with the view above, the number of stomata and venation density are less in leaves from the former plant.

Leaves from Stations A, C, and F were now studied under the heads enumerated below in relation to further results obtained by Zalenski, who states that, in comparison with the state of affairs in the lower leaves, the higher a leaf is inserted :

1. The greater the development of mechanical tissue.
2. The more typical the development of palisade tissue.
3. The less typical the development of spongy mesophyll.
4. The weaker the development of the system of intercellular spaces.
5. The smaller the dimensions of all kinds of mesophyll cells.
6. The thicker the outer wall of both upper and lower epidermal cells.
7. The smaller the dimensions of both upper and lower epidermal cells.
8. The less sinuous the lateral walls of the epidermal cells.

Results in this work dealing with a single leaf :

1. *Mechanical Tissue.*—This is collenchyma and present in three areas of the leaf : at the two margins, and in the middle, just above the lower epidermis. The total number of collenchymatous cells decreased from base to apex.

2. *Development of Palisade and Mesophyll Tissue.*—There is a progressive increase of palisade tissue from base to apex and a corresponding decrease in spongy mesophyll.

3. *Intercellular Spaces.*—These become progressively fewer and smaller from base to apex, both in spongy mesophyll and palisade.

4. *Size of Mesophyll Cells.*—In Stations F and A these become progressively smaller from base to apex, while in Station C they are biggest at the middle, smallest at the apex, and intermediate at the base.

5. *Thickness of Outer Epidermal Wall.*—There is a slight

tendency to increase in thickness from base to apex, especially in a leaf from Station F.

6. *Sinuosity of Lateral Walls of Epidermal Cells.*—Sinuosity increases from base to apex in leaves from Stations C and A. The change is scarcely distinguishable in Station F.

7. *Thickness of Cuticle.*—There is no appreciable difference from level to level or from station to station.

Histology of Leaf (additional features common to all the leaves).—The stomata have subsidiary guard cells. The outer wall of these cells, as well as of the guard cells, is cutinised. There are no water stomata. The principal meristeles run parallel. They are normal, but are supported above and below by stereom crescents. The whole is enclosed in an endodermal sheath containing starch grains. The whole of the radial wall of these endodermal cells is cutinised.

Histology of the Rootstock (Station A).—Both periderm and secondary stelar thickening begin extremely early. The phellogen originates several cells deep in the cortex, while the stelar cambium lays down radial rows of secondary parenchyma.

Histology of Root.—As in the rootstock, both kinds of secondary thickening begin very early. Even the fine fibrous roots collected at a depth of about 3 feet did not reveal the primary structure. Sections of these showed a diarch stele with medullation setting in. The thickness is mainly due to the abnormal amount of secondary cortex. Instead of secondary xylem, the stelar cambium lays down radial rows of parenchyma.

Propagating experiments with leaves of *Plantago maritima* (at 30° C.):

A. Lying horizontally, with basal cm. covered by soil.
    1. Entire.
    2. Entire, but slashed transversely.
    3. Entire, but slashed longitudinally.
    4. Base removed.
    5. Base plus basal third of lamina removed.
    6. Apical and basal third of lamina removed.
B. Inserted vertically.
    1. Entire.
    2. Base removed.
    3. Base plus basal third removed.

Within a month all had wilted and died except one—one which had had its base removed and was lying horizontally (A 4). This one had developed two branched roots from the cut surface. Even this one positive result proves that it may be possible to propagate *Plantago maritima* vegetatively by means of leaves, especially as these experiments were carried out at the end of the season, when the leaves were waning in vitality.

Further propagating experiments with

1. Rootstocks alone.
2. Rootstocks with leaves still attached.

A. Inserted vertically.
    1. Basal cm. removed—upper four cm., bearing leaves, inserted in soil.
    2. Basal and apical cm. removed. The apical end placed in soil.
    3. As A 2, but basal end in soil.

B. Lying horizontally.
    1. Basal and apical ends removed.

All developed roots from the basal cut surface. Those which had no leaves originally developed them from the apical cut surface. They grew strongly for a time but eventually, after thirty-four days, all had died. This was probably due to frequent handling for measuring purposes and also to the unfavourable season (28th October to 1st December).

The writer wishes to express his indebtedness for facilities and assistance afforded him at the Botanical Department, St. Andrews.

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NOTES ON SALT-MARSH PLANTS. III. TRIGLOCHIN MARITIMUM LINN. By JAMES PARK, B.SC.

(Read 18th June 1931.)

Hill has given an account of the morphology and anatomy of the vegetative organs and inflorescence axis, together with the development of the flower, anatomy of the embryo sac, and the embryogeny (1).

A comparative account of the leaves of eleven different species of *Triglochin* is submitted by Arber (2).

The *Triglochin maritimum* used in this investigation was collected from several places in the salt marsh at the Eden estuary ; the different positions have varied soil constituents, water-content, and pH concentration. Examination in the field revealed no differences in external morphology in plants from different stations.

THE LEAF IN RELATION TO ZALENSKI'S HYPOTHESIS.

Zalenski's hypothesis is outlined in Maximov's "Plant in Relation to Water" (3), and has been alluded to in papers I. and II. on Salt-Marsh Plants (*supra*).

Points corroborated in the work are as follows :—

In leaves of *Triglochin* from base to tip of the leaf, there is

(1) an increase in the number of stomata per unit area of leaf surface, the numbers being approximately equal on both sides of the leaf.

(2) From base to tip of the leaf there is a decrease in the size of the stomatal apparatus of the epidermal cells, while the longitudinal walls become less regular towards the leaf tip.

(3) The average size of all the elements decreases from base to tip of the leaf, the palisade mesophyll showing the least change.

(4) The proportion of palisade to spongy mesophyll increases from base to tip of the leaf.

(5) The outer wall of the epidermis, which is of cellulose, is very markedly thicker at the tip than at the base.

The actual variation in thickness of the cuticle is negligible.

(6) The sheaths of thickening are less prominent at the tip of the leaf.

(7) The intercellular spaces are much more marked towards the base of the leaf.

A comparative study of consecutive parts of a leaf with regard to venation is not very satisfactory, due to the shape of the leaf. However, the number of strands passing unit length of circumference and passing unit area of cross-section of the leaf were measured, and it was found that in both cases the number increased from the base to the tip of the leaf. This may be correlated with the stomatal distribution.

In conclusion, it is considered that though some of the facts mentioned might be explained as due to condensation towards the leaf tip, Zalenski's hypothesis may be applicable to single leaves of the *Triglochin* type.

Germination of Seed and Growth of Seedling.

The seeds are enclosed one per carpel and are dispersed inside the latter in a manner similar to those of *Geraniaceae*, the style remaining probably as a hook for dispersal.

The seed is anatropous, with a membraneous seed-coat, exendospermic, embryo straight, average length 1·5 mm., and average breadth ·5 mm. The embryo is differentiated to primary root, hypocotyl, and cotyledon, while another leaf may be differentiated in the plumule.

Seeds planted in October did not show till the middle of January, but those planted after that time germinated in about 1½ days after sowing. Germination is epigeal, the seed-coat and carpel being carried above ground covering the cotyledon tip. The seed-coat is often carried out on the primary root when seedlings are grown on wet filter paper. The percentage germination was 64 per cent.

There is a well-developed piliferous layer in three days, the second leaf appears in about nine days, but the root grows very slowly. In a month-old seedling four leaves are generally developed, including the cotyledon, which is about 3 cm. long.

The distichous arrangement of the leaves is readily seen. A ligule is present in the first plumular leaf but is not differentiated in the cotyledon. One or two adventitious roots have developed laterally from the base of the hypocotyl, the first soon reaching the length of the primary root.

ANATOMY OF TWO-WEEKS-OLD SEEDLING.

In a two-weeks-old seedling two leaves are easily visible, the cotyledon being about 18 mm. long. The distribution of the vascular bundles about the third node is shown in fig. 1 (i).

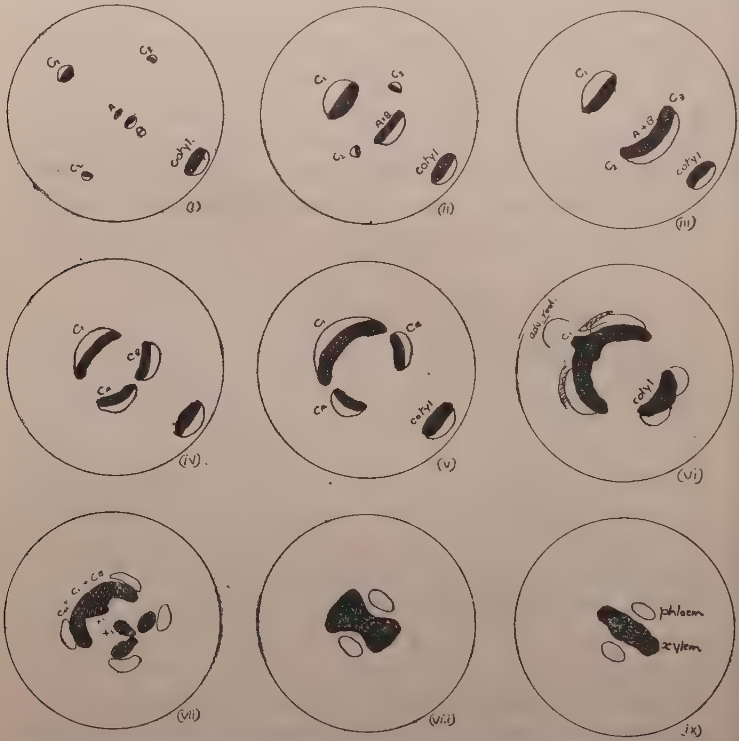

FIG. 1.—*Triglochin maritimum*. Diagrammatic transverse sections of 2-weeks-old seedling, showing stages in transition from plumule to root.

A and B represent the rudiments of the leaf traces of the third and second leaves respectively, C_1, C_2, C_3 those of the first leaf, and "Cotyl" the cotyledonary trace. Thereafter the course of the bundles can be followed from the diagrams. A and B fuse (fig. 1, ii) C_2 and C_3, the lateral strands of the first leaf trace join the ends of the fusion system A and B (fig. 1, iii). The bundle so formed breaks to two parts (fig. 1, iv). These parts C_A and C_B become attached to the ends of the main strand of the first leaf trace C_1, forming a semicircle (fig. 1, vi). From C_1 the stele of the first adventitious root is given off while the cotyledonary trace enters opposite (fig. 1, vi). The phloem up to this point has been more or less in its usual position, external to the xylem, but it is very scanty. The cotyledonary phloem breaks to two patches, as also does that of the patch $C_1+C_A+C_B$ (fig. 1, vii). The cotyledonary xylem strand breaks up too, protrusions x_1+x_2 are produced from both xylem patches, which ultimately join the two patches to form a diarch stele with lateral protrusions (fig. 1, viii). About the same place the lacunar cortex of the normal root becomes evident and the section is reduced in diameter. A normal diarch stele is produced (fig. 1, ix), the xylem being finally reduced to two patches of protoxylem, joined by thin-walled tissue.

The distance between sections represented by figs. 1 (i) and 1 (vi), was ·35 mm., that between 1 (vi) and 1 (ix) about ·2 mm.

Anatomy of Four-Weeks-Old Seedling.

A four-weeks-old seedling shows three leaves besides the cotyledon, the latter being about 3 cm. long. One adventitious root is generally developed, being as long as the primary root. The hypocotylary region is still very small, less than ·5 mm.

Fig. 2 (i–x) shows diagrammatically the positions of the leaf traces. Six leaves were already differentiated in the plumule.

Fig. 2 (i) shows a section about the fifth node, the leaf traces of the first to fifth leaves being lettered E–A respectively. The side strands of the fourth leaf, B_2 and B_3, fuse with A, the main strand of the fifth leaf trace, which then fuses with the fourth main strand, B. The mass of xylem so formed breaks to two parts, b_1 and b_2 (fig. 2, ii), which fuse with C_2 and C_3, the side bundles of the third leaf trace. The second leaf trace, D_1, D_2, D_3, now enters (fig. 2 iii) the side strands, D_2 and D_3, fusing with main strand, C_1, of the third leaf, while D_1 fuses with the two side bundles represented by b_1+C_2,

b_2+C_3 (fig. 2, iv). The patch formed from the third leaf trace now breaks to two parts, d_1 and d_2, which join to the ends of the main strand, E, of the first leaf trace (fig. 2, vi). The side bundles, E_2 and E_3, join near the ends of d_1 and d_2 (fig. 2, vi). The xylem patches are, however, much broken up now, so the junction of the side strands, E_2 and E_3, of the first leaf is not definite (fig. 2, vii). The stele of the second adventitious root is given off from D_1, while E_1 enters opposite (fig. 2, viii). After the position represented in fig. 2 (vi) is reached, there is a period during which the relative position of the xylem and phloem varies much, chiefly due to the formation (fig. 2, (vii)) of what are apparently rudimentary concentric bundles as are found in the adult rhizome. However, the xylem finally becomes approximately arranged in

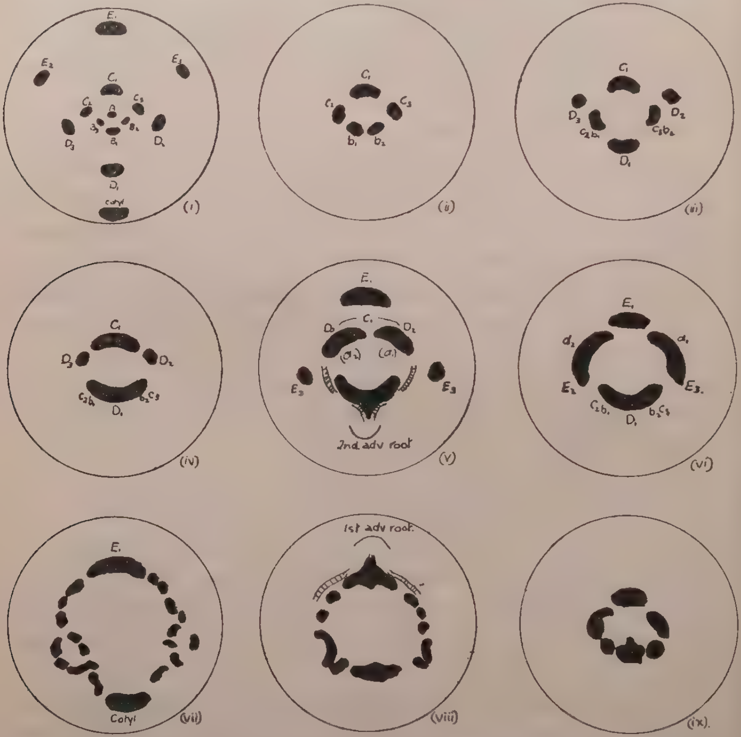

FIG. 2.—*Triglochin maritimum.* Diagrammatic transverse sections of 4-weeks-old seedling, showing leaf-trace system, origin of adventitious roots, and beginning of transition period.

a circle before the stele of the first adventitious root is given off, and before the joining of the cotyledonary trace opposite (fig. 2, viii). The stele becomes much condensed now, the xylem becoming medullated in various ways and the phloem almost disappearing, till finally an appearance is assumed approximating to that of the two-weeks-old seedling as before (fig. 1, viii). The stele looks like a tetarch stele, but four patches of phloem were not traced. A normal diarch stele is formed by the withdrawal of the protrusions.

It is remarked from the above description and a comparison of fig. 2 (i and iv, iii and v), that the leaf-trace system is symmetrical and that the roots, in the seedling at least, arise opposite the entry of a leaf trace.

The origin of the bundle sheaths, which are such a marked feature of adult leaves, is seen to be endodermal, but they were not apparent in seedlings till about a month old.

Seedlings of intermediate ages between these described were examined and were found to conform to those. Though the medullation in the transition region is by no means constant, the final result is a diarch root stele with protrusions as described.

The writer wishes to express his indebtedness for the facilities given him for carrying out the work in the laboratory at St. Andrews University.

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The Scottish Alpine Botanical Club Excursion, 1930.

By Robert Moyes Adam. (With Pls. XX–XXI.)

(Read 15th October 1930.)

The scene of the 1930 excursion was fixed for Achnashellach in West Ross-shire, the Club having been invited to be the guests of Mr. and Mrs. Sandeman at their lodge. A few days, however, before the date of the meeting word was received by the President that serious illness had overtaken Mrs. Sandeman, and consequently all arrangements were abandoned.

Thereafter, in consultation with the President and Secretary, an alternative rendezvous was chosen for the Club meet at Loch Laggan Hotel, and in which place subsequently, on 16th July, a representative gathering took up residence. This region, which was new to the Club, had much to commend it. The published records of the botany are few, and within accessible distance lie some big tracts of elevated land with attractive corries.

Loch Laggan must be reached by road, and the Club made this approach by motor-car from Kingussie—a pleasant route, first through Newtonmore and thence by skirting the Monadhliath Hills, where birch woods fringe the lower slopes—past Cluny Castle, with its Jacobite memories, to Laggan village. From Laggan the route bears south-west and crosses the infant Spey to enter Strathmashie, and finally reaches the valley of the Pattock, a short river which rises on the north-east side of Ben Alder, and performs a semicircular course to escape from the Spey watershed and so drain south-west and enter Loch Laggan.

The latter part of the route introduced members to the vast afforestation schemes begun some sixty years ago by the late Sir John Ramsden, Bart., and continued now by his son, the present baronet. These larch and pine plantations, with other conifers, present an instructive example of foresight and enthusiasm in the art of creating forest. Fifty years ago most of this landscape was treeless, while to-day there are many square miles of growing timber. The area

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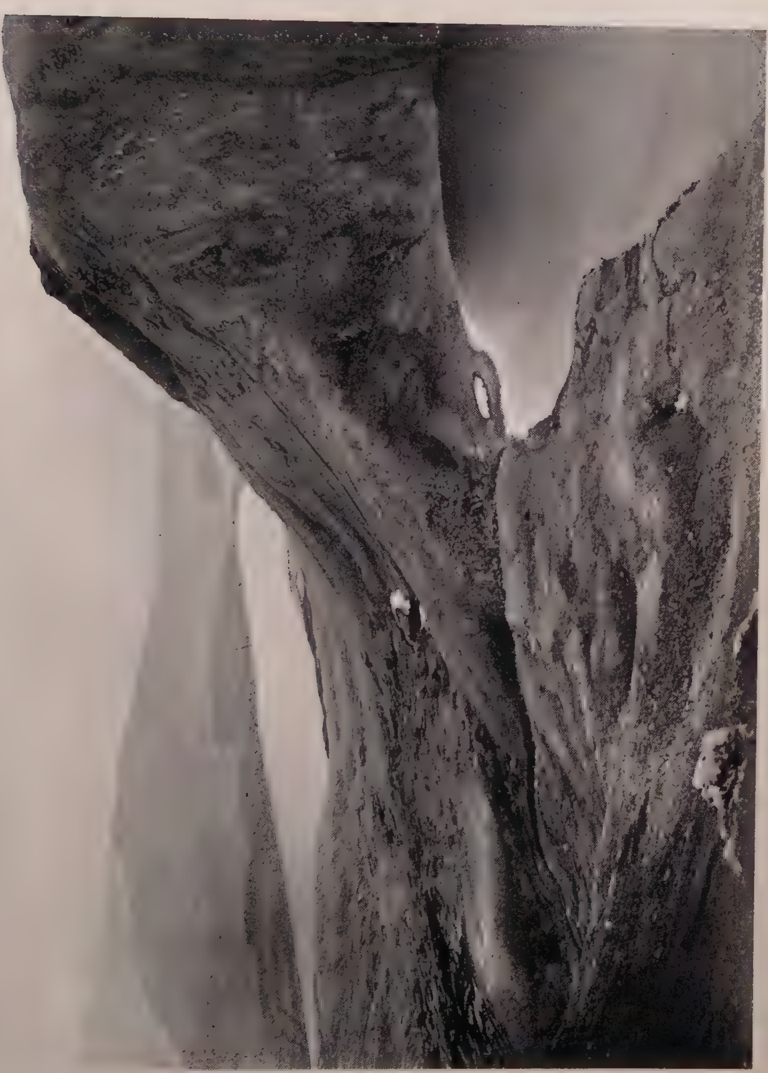


Coire Coille na Froise with the lochan that lies at the base of the cliffs, Loch Laggan in the distance.

Robert Moyes Adam.

owned by the Ramsdens extends to 10 miles in every direction from their residence at Ardverikie, and should their schemes mature all plantable land will be afforested.

This region possesses more than ordinary attractiveness, and it is of interest to record that the late Queen Victoria sought to establish her highland home at Ardverikie before her choice of Deeside.

After installing themselves in the hotel, the Club party spent the evening making contact with the factor of Ardverikie, a genial fellow by name Mr. Thomas Logan. From him a welcome was extended to the Club in the name of Sir John Ramsden, who further let it be known that the Club were at liberty to exploit in the fullest measure all the botanical interests of his estate—a privilege the Club appreciated highly and which was acknowledged on behalf of the Club by the President.

In a field near the factor's house at Gallovie some fine plants of *Leucorchis albida* were seen in full flower, and in a pine plantation some remarkable white foxgloves, a few of which exhibited Peloria.

The great day of the meet was on 17th July, plans having been made to tackle one or more of the great corries facing east on Creag Meaghaidh—the big green hill that dominates the horizon west of Loch Laggan, now part of Aberarder Deer Forest, but formerly used as a sheep run.

For the outward journey the Club sought assistance from the hotel car, and by its means were conveyed to Moy, six miles distant and at the south-western extremity of Loch Laggan. Moy in the old days was a stage house for posting traffic between Strathspey and Fort William—it is now occupied by an Ardverikie stalker.

The weather prospects on setting out were distinctly gloomy, and rain commenced after dismissing the car, and continued intermittently throughout the day. A steady pull uphill above Moy brought members over a moor dominated by *Scirpus caespitosus*, and in the bogs *Drosera anglica* was plentiful. Beyond the 1000-foot contour the vegetation changed, and in place of heath a wilderness of boulders strewed the hillside, which made the ascent tedious. Around 1800 feet more heath appeared, and among it *Cornus suecica* —numerous plants, but flowerless. On a small cliff the first rock alpines appeared in *Saxifraga stellaris* and *Salix Lapponum*.

Thereafter the ascent became steeper and plant life less luxuriant. The slope became carpeted with stunted *Calluna*, *Empetrum*, and *Vaccinium Myrtillus*, and, mixed in, plants of *Loiseleuria procumbens*, prostrate and hugging the windswept surface. At 2000 feet rocky outcrops indicated the entrance to Coire Coille na Froise, and the first to be explored. Mist and low clouds hid the summit and threatened to drop lower, but these conditions did not prevent a thorough examination of several gullies at this point. Rewards were few, as the rocks were found to be dry and with an angle of slope unfavourable to plants.

A mile distant the innermost recess of the corry could be seen between the clouds with an apparent series of gullies descending sharply to a tiny lochan at their base. By traversing along the south side of the corry and keeping just below the cloud level, which was about 2600 feet, rocks were ultimately reached with quite favourable aspects and holding a wealth of vegetation. Over many parts water flowed freely —some apparently from large snow-patches on the higher levels in the corry. In one gully over 200 feet of snow lay to a depth of 15 feet. At one part the underside had melted to form an arch a few inches above the scree—where *Caltha palustris* had quite a show of flowers, yet a few feet distant, and where no snow lay, Marigolds were just in leaf. Over some ledges quantities of *Saussurea alpina* were just in bud, *Trollius europaeus* in flower, and on ledges with abundant soil a riot of plants, among which *Rubus saxatilis* and *Luzula sylvatica* seemed to dominate. Some *Silene acaulis* was seen in flower, but this plant was not plentiful, and where the splashing of the dripping rocks kept the soil wet some splendid flowering groups rose of *Saxifraga hypnoides*. On the scree slopes, where fresh water flushes made their way, clumps of *Carex* throve, and conspicuous among their number the dark heads of *Carex pulla*. In similar situations the alpine grasses *Alopecurus alpinus* and *Phleum alpinum* threw up many tall heads. At one place in the corry progress was barred until a descent to the lochan enabled the party to escape from a difficult cliff. The ascent on the far side, however, compensated and gave access to some attractive terraces at the head of the corry. Over this ground great plants of *Cochlearia alpina* appeared in full bloom, and on the side of the chief stream which fed the lochan, and where it fell over precipitous rocks, many plant discoveries were made.

About this time the clouds lifted and encouraged the party to ascend to the summit of the corry, which, being accomplished, brought them towards the north shoulder, where the elevation reached 3400 feet. From this vantage point the corry was viewed—a scene wild and desolate—a wide amphitheatre of rocks and scree in the foreground, while far beneath the tiny lochan looking dark and still. Beyond and to the east the big hills about Ben Alder appeared dimly in the gloom. Westwards the eye roamed over a wide plateau—the summit of Creag Mheaghaidh, the top so flat that an aeroplane could land with safety, and a slight rise to the cairn which denoted the 3700-foot point. The surface soil was peaty and showed little signs of erosion in spite of the elevation, and the whole carried a splendid cover of Nardus grassland.

From the view-point a move for half a mile in a north-westerly direction brought the party to the brim of Coir Ardoir—Creag Meggie's grandest corry—a scene of awesome grandeur with perhaps few rivals of its kind in the Scottish Highlands. The edge of the corry reaches the 3600-foot elevation, and from it descend a series of precipices, which vary in height and steepness. Two great buttresses in the centre drop down sheer for 1200 feet. These are known as the "Posts" of Coir Ardoir, and are to ordinary hill-folk unscaleable. A notch-shaped depression towards the north-west corner of the corry is the "Window of Coir Ardoir," and is a well-known feature in the mountain outline when viewed from the east. Through this gap the pass connecting Laggan to Glen Roy reaches an elevation of 2800 feet, and was used by Prince Charles Edward during his flight after Culloden, and when on his way to Badenoch in 1746.

An approaching rainstorm cut short botanizing operations on the summit, and the party made a rapid descent by the side of a long snow slope, and ultimately reached the level of the lochan that nestles at the base of the cliffs. At this point the deer forest track was struck, and by its aid the final stage of the day's march was begun. Some very intimate sights of Red Deer grazing the slopes in the lower parts of the glen enlivened the three miles of rough walking, and ultimately brought the party within sight of the road at Aberarder Farm.

The final stage was completed by car, and after a 12-hour day in the field the hotel was reached, with the opinion formed that in spite of the weather a profitable day had been spent and an important record added to the Club annals of lesser-known territory.

The 18th of July brought rainy weather, and consequently a light programme was carried through.

The forenoon was spent in the vicinity of the hotel, and with a walk down Loch Laggan towards Aberarder. Where the River Pattock entered the loch the abnormally low state of the water was evident from the large sandbanks that were exposed, rendering the loch at this end fordable.

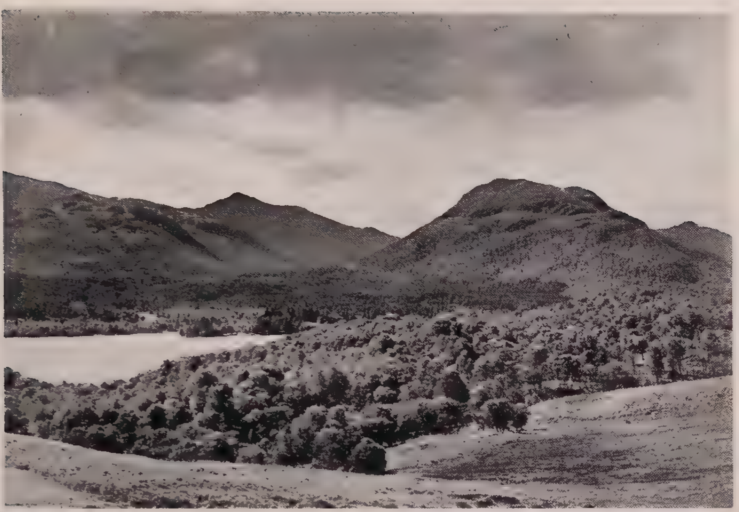
After lunch the woods of Ardverikie were visited, and this was done by entering the policies by the main gateway and iron bridge over the Pattock. From the bridge the party kept to the main avenue—a beautiful walk, on both sides of which common and rare conifers were observed in all stages of growth. The avenue skirts the shore for nearly three miles, and throughout its length offers particularly fine glimpses of Loch Laggan, the best view-points having been improved by the removal of trees which at one time must have interfered with the prospect. On the margin of the avenue several groups of *Pyrola minor* were seen in fine flower, and in the forest region close by Ardverikie Castle Rhododendrons formed quite a jungle of growth.

Continuous rain made the afternoon unpleasant, and after reaching Ardverikie the route was reversed and a speedy return made to the hotel.

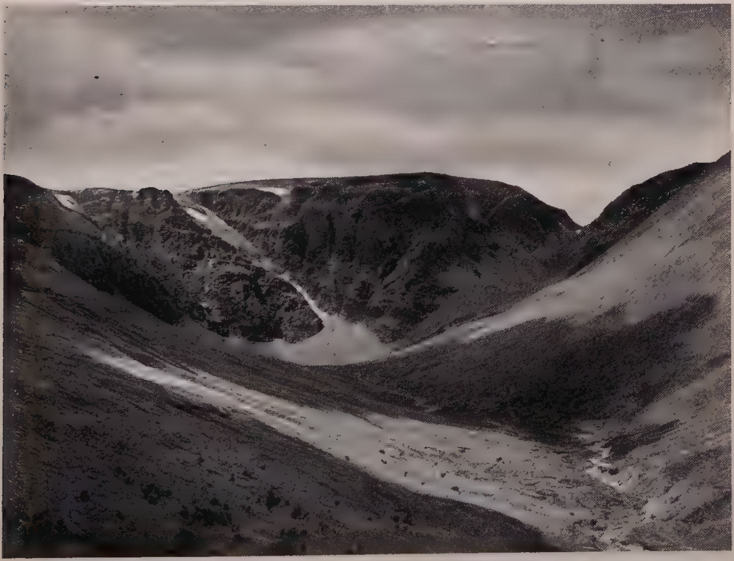
On the 19th the Club woke to good weather and their departure, but as this hour was not until afternoon an energetic member set off to explore the slopes of Carn Liath and the slopes of Coir Ardoir. He returned in time to join the departing company, having collected quantities of *Rubus chamaemorus* in excellent fruit on the high slopes of Carn Liath at 2000 feet.

The Club meet drew to a close with the arrival of the mail coach, thereafter conveyance to Kingussie to entrain, and their separate destinations.

The following plants were noted: *Thalictrum alpinum* Linn.,



Ardverikie, Loch Lagganside, showing afforested lands and the summits of Beinn Shios and Creag Peathraich on the horizon.



The summit of Creag Meaghaidh, with the precipices of Coire Ard Dhoire. The " window " is the notch-shaped depression on the skyline, and the " posts " are the rock buttresses in the centre.

ROBERT MOYES ADAM.

Caltha palustris Linn., *Trollius europaeus* Linn., *Cochlearia alpina* Wats., *Silene acaulis* Linn., *Cerastium alpinum* Linn., *Prunus Padus* Linn., *Rubus saxatilis* Linn., *R. Chamaemorus* Linn., *Geum rivale* Linn., *Potentilla Sibbaldi* Hall. fil., *Alchemilla alpina* Linn., *Saxifraga aizoides* Linn., *Sedum roseum* Scop., *Drosera anglica* Huds., *Epilobium anagallidifolium* Lam., *Angelica sylvestris* Linn., *Cornus suecica* Linn., *Galium boreale* Linn., *G. saxatile* Linn., *Gnaphalium supinum* Linn., *Saussurea alpina* DC., *Vaccinium uliginosum* Linn., *Azalea procumbens* Linn., *Pyrola minor* Linn., *Gentiana campestris* Linn., *Veronica humifusa* Dickson, *V. alpina* Linn., *Salix lapponum* Linn., *S. herbacea* Linn., *Gymnadenia conopsea* Br., *Leucorchis albida* Mey., *Juncus trifidus* Linn., *J. castaneus* Sm., *J. biglumis* Linn., *Triglochin palustre* Linn., *Carex canescens* Lightf., *C. leporina* Linn., *C. rigida* Good., *C. pallescens* Linn., *C. binervis* Sm., *C. flava* Linn., *C. saxatilis* Linn., *Alopecurus alpinus* Sm., *Phleum alpinum* Linn., *Cryptogramme crispa* Br., *Cystopteris fragilis* Bernh., *Polystichum Lonchitis* Roth, *Phegopteris Dryopteris* Fée, *P. polypodioides* Fée, and *Lycopodium alpinum* Linn.

NOTES ON COMMON DISEASES SOMETIMES SEED-BORNE.

By N. L. ALCOCK, F.L.S.

(Read 15th October 1931.)

The list of seed-borne diseases here put forward is not definitive, and only given tentatively. The arrangement of plants is that adopted by the Ministry of Agriculture in Miscellaneous Publications, No. 70, "Fungus and Allied Diseases of Crops."

It is hoped that further work will be done on these diseases at the Royal Botanic Garden, and photographs of the stages of the fungi on the seed obtained.

ROOTS.

SWEDES.

Dry Rot (*Phoma Lingam* (Tode) Desm.).
Downy Mildew (*Peronospora parasitica* (Pers.) Tul.).
Powdery Mildew (*Erysiphe Polygoni* DC.).

TURNIPS.

Dry Rot (*Phoma Lingam* (Tode) Desm.).

Swede and Turnip seed that carry this disease appear discoloured, wrinkled, and dull, possibly showing a little mycelium or threads. The small pycnidia (black minute bodies) are very seldom seen, but on germinating the seed in sterile conditions they may appear plentifully after about three weeks on the young stem and first two leaves.

Downy Mildew (*Peronospora parasitica* (Pers.) Tul.).

Downy Mildew does not usually appear on the seed, but in a badly affected sample the oospores may sometimes be found (with a microscope) on washing the seed and on any pieces of the plant that have escaped cleaning.

White Blister (*Cystopus candidus* (Pers.) de Bary).

This may rarely be seen as minute white spots on the seed, but more often on small particles of plant tissue. Rare.

Black Rot (*Pseudomonas campestris* (Pamm.) E. F. Smith).

MANGOLDS.

Rust (*Uromyces Betae* (Pers.) Tul.).
Black Leg (*Phoma Betae* (Oud.) Frank).
Rhizoctonia sp.

SUGAR BEET.

Rust (*Uromyces Betae* (Pers.) Tul.).

Rust on the compound seed of Beet or Mangold usually appears as yellow spots, these are sori containing uredospores. The seed is lighter in weight but darker in colour than usual. The spots need a lens to be seen, and may be hidden in the folds of the compound seed.

Black Leg (*Phoma Betae* (Oud.) Frank).

Black Leg appears as pycnidia (*i.e.* small black bodies full of spores) on the compound seed case, to be seen with a lens. It may wipe out seedlings.

Rhizoctonia sp.

This fungus, which is very common among Beet and Mangolds and various seeds, occurs as brown threads only. It acts as a damping-off fungus and may be troublesome. If plentiful, it can be seen with a lens and the seeds will be dark and dirty looking.

Mildew (*Peronospora Schachtii* Fuckel).

Leach found mycelium and oospores on the seed-coat.

PULSE.

DWARF BEANS.

Pod Canker (*Colletotrichum Lindemuthianum* (Sacc. et Magn.) Bri. et Cav.).

RUNNER BEANS.

Pod Canker (*Colletotrichum Lindemuthianum* (Sacc. et Magn.) Bri. et Cav.).

Pod Canker appears on the seed of Dwarf and Runner Beans as a depressed area, light brown usually with a purple rim. If the bean is soaked and examined, some mycelium (fungus threads) will be found under the seed coat.

BROAD BEANS.

Rust (*Uromyces Fabae* (Pers.) de Bary).

Rust on Broad Beans is more likely to be carried on little pieces of pod or stem, appearing as yellow-brown spots.

Chocolate Spot (*Bacillus Lathyri* Manns et Taubenh.).

This bacterial disease has been found on Beans from a diseased crop and shows as a dark chocolate-brown spot. It is carried by *Bruchus rufomaculans*, the Bean Beetle. Bored seed should be avoided.

FIELD AND GARDEN PEAS.

Powdery Mildew (*Erysiphe Polygoni* DC.).

Downy Mildew (*Peronospora Viciae* (Berk.) de Bary).

Downy Mildew of Peas sometimes attacks the pods very severely. Wrinkled, discoloured spots occur on the seeds, and sometimes oospores or resting spores can be found (microscope) in the seed coats.

Spot (*Ascochyta Pisi* Lib.).

This is carried as small pycnidia, showing as brown, not black, minute bodies on the pod. When the disease is severe, the infection goes through the pod to the seed.

Stripe (*Bacillus Lathyri* Manns et Taubenh.).

This causes a discoloured spot in the centre of the seed that can be seen if the seed be cut.

FORAGE CROPS.

CLOVER.

Rust (*Uromyces Trifolii* (Hedw. f.) Lév.).

Black Blotch (*Dothidella Trifolii* (Pers.) Bayl.-Elliot et Stans.).

Leaf Spot (*Pseudopeziza Trifolii* (Biv.-Bern.) Fuck.).

Sclerotinia Trifoliorum var. *minor* (?).

This small sclerotinial disease borne by Clover seed may not occur on seed grown in this country, but has been found on seed from abroad, and the fungus grown out in the Laboratory. The other three Clover diseases require further research.

Scorch (*Kabatiella caulivorum* (Kirchn.) Karak.).

This has been found to be carried on the seed.

VEGETABLES.

ARTICHOKE (Jerusalem).

Sclerotinia Sclerotiorum (Lib.) de Bary.

This fungus has been grown in culture from small sclerotia on the seed.

BEET.

Rust (*Uromyces Betae* (Pers.) Tul.).

See note on Mangold and Sugar Beet.

BRASSICAE.

Stem Rot (*Phoma Lingam* (Tode) Desm.).
Downy Mildew (*Peronospora parasitica* (Pers.) Tul.).
Black Rot (*Pseudomonas campestris* (Pamm.) E. F. Smith).

CARROT.

Sclerotinia Sclerotiorum (Lib.) de Bary.
Rhizoctonia sp.

CELERY.

Leaf Spot (*Septoria Apii* Chester).

LEEK.

Rust (*Puccinia Porri* (Sow.) Winter).
Smut (*Urocystis Cepulae* Frost).

LETTUCE.

Ring Spot (*Marssonina panattoniana* Berl.) (doubtful).

ONIONS AND SHALLOTS.

Mildew (*Peronospora Schleideni* Ung.).
Rust (*Puccinia Porri* (Sow.) Winter).
Macrosporium parasiticum Thüm.

In examining samples of Leek and Onion seed, I have not found the spores of Smut, but oospores of Mildew, and spores of *Macrosporium* are often present.

PARSLEY.

Leaf Spot (*Septoria Petroselini* Desm.).

SALSIFY.

White Rust (*Cystopus cubicus* (Strauss) de Bary).
Smut (*Ustilago Tragopogonis pratensis* (Pers.) Rouss.) (rare).

TOMATO.

Mosaic (Virus disease).

Experiments in recent years at Cheshunt have shown that this is seed-borne.

Canker or Stem Rot (*Diplodina Lycopersici* (Cooke) Hollós).

Buck-eye Rot (*Phytophthora parasitica* Dastur).

This is probably seed-borne from badly infected fruits and may be one of the causes of damping-off.

FLAX.

FLAX.

Rust (*Melampsora Lini* (Pers.) Desm.).

Seedling Blight (*Colletotrichum Lini* (Westerd.) Toch.).

FLOWERS.

ANTIRRHINUM.

Stem Rot (*Phyllosticta Antirrhini* (Syd.)).

DAHLIA.

Sclerotinia Sclerotiorum (Lib.) de Bary.

In this case the fungus makes sclerotia, or black lumps, on the seeds similar to those formed on the Salsify seed.

MECONOPSIS sp.

Downy Mildew (*Peronospora arborescens* (Berk.) de Bary).

SWEET PEAS.

Streak (*Bacillus Lathyri* Manns et Taubenh.).

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LIST OF FUNGOUS DISEASES RECEIVED BY THE PATHOLOGICAL DEPARTMENT OF THE DEPARTMENT OF AGRICULTURE FOR SCOTLAND. By N. L. ALCOCK, F.L.S., AND C. E. FOISTER, B.A., Ph.D.

(Read 15th October 1931.)

The list now presented is that of diseases on plants that have been received since 1924 at the Plant Pathology Laboratory of the Department of Agriculture for Scotland, stationed at the Royal Botanic Garden, Edinburgh.

In the earlier years the plants sent in for diagnosis were not numerous, but the variety and number of diseases received have steadily increased in recent years as interest grew.

This is not in any way a complete survey, but shows briefly the advisory work of this Laboratory. It also suggests what might be done in the future, with more time and greater opportunities, in the compilation of a complete survey of plant diseases in Scotland.

The localities are not exclusive; they are places whence the diseases were received. Many of the diseases are widespread.

The scientific names are arranged according to the list of the British Mycological Society, published in their Transactions, xiv (1929), 140–177. The economic crop plants are arranged as in the Ministry of Agriculture and Fisheries Miscellaneous Publications, 70, "Fungus and Allied Diseases of Crops, 1925–1927."

In the question of critical determination thanks are due to Dr. Malcolm Wilson, whose great assistance is hereby gratefully acknowledged.

FRUIT.

APPLE.	*Locality*
Scab (*Venturia inaequalis* Aderh.)	General
Mildew (*Podosphaera leucotricha* (Ell. et Everh.) Salm.)	do.
Canker (*Nectria galligena* Bres.)	do.
Coral Spot (*Nectria cinnabarina* (Tode) Fr.). (Acting as a Canker)	East Coast
Rough Scab (*Coniothecium chomatosporum* Corda). (Fruit cracking)	Lothians
Silver Leaf (*Stereum purpureum* Pers.).	Distributed, but not common

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	Locality
Brown Rot (*Sclerotinia fructigena* Schroet.)	General
Blossom Wilt (*Sclerotinia cinerea* Schroet.)	do.
Bitter Rot (*Glomerella cingulata* (Stonem.) Spauld. et v. Schrenk) (on imported fruit).	
Fruit Rot (*Phytophthora Syringae* Klebahn)	Moray Firth, Nairn
,, (*Phytophthora Cactorum* (Leb. and Cohn) Schroet. has been suspected, but not proved, in some cases)	Edinburgh, locally common
Leaf Blotch (*Phyllosticta solitaria* Ell. et Everh.)	Ayr (1 case)
Black Rot (*Physalospora Cydoniae* Arnaud)	Imported
Scorch (Physiological).	
Brown Heart (Storage trouble).	

PEAR.

Scab (*Venturia pirina* Aderh.)	General
Canker (*Nectria galligena* Bres.)	Forfar and Ayr
,, (*Nectria cinnabarina* (Tode) Fr.) (parasitic)	Midlothian and Stirling
Blossom Wilt (*Sclerotinia cinerea* Schroet.)	Blairgowrie, Perth
Leaf Blister (*Taphrina bullata* (Berk.) Tul.)	Argyll
Leaf Fleck (*Septoria piricola* Desm.) (Perfect stage is *Mycosphaerella sentina* (Fr.) Schroet.)	Ayr
Sleepiness (Storage trouble).	

PLUM.

Silver Leaf (*Stereum purpureum* Pers.)	Not very common in Scotland
Blossom Wilt, Wither Tip, and Brown Rot (*Sclerotinia cinerea* Schroet.)	General
Rust (*Puccinia Pruni-spinosae* Pers.)	Lothians and Nairn
Scab (*Cladosporium carpophilum* Thüm.=*Fusicladium carpophilum* (Thüm.) Oud.)	Selkirk
Pocket Plums (*Taphrina Pruni* (Fuckel) Tul.)	Not common, Lothians
Die Back (*Diaporthe perniciosa* Marchal and *Cytospora* sp. associated) doubtfully parasitic.	
Bacterial Canker (*Pseudomonas prunicola* Wormald)	Clackmannan

CHERRY.

Brown Rot and Blossom Wilt (*Sclerotinia cinerea* Schroet.)	Distributed
Bitter Rot (*Glomerella cingulata* (Stonem.) Sp. et v. Sch.=*G. rufomaculans* (Berk.) Sp. et v. Sch.)	Jura
Witches' Broom (*Taphrina Cerasi* (Fckl.) Sadeb.)	Lanark
Leaf Curl (*Taphrina minor* Sadeb.)	do.

PEACH (Glasshouse).

Leaf Curl (*Taphrina deformans* (Berk.) Tul.)	Distributed
Brown Rot (*Sclerotinia cinerea* Schroet.)	Lothians (occasional)
Silver Leaf (*Stereum purpureum* Pers.)	Stirling
Shot Hole (*Clasterosporium carpophilum* (Lév.) Aderh.)	Argyll (rare)

	Locality
Scab (*Cladosporium carpophilum* Thüm.)	Occasional
Mildew (*Sphaerotheca pannosa* (Wallr.) Lév. var. *persicae* Woron.)	Edinburgh
APRICOT.	
Coral Spot (*Nectria cinnabarina* (Tode) Fr.)	Fife and Edinburgh
ALMOND.	
Leaf Curl (*Taphrina deformans* (Berk.) Tul.)	Fife and general
GOOSEBERRY.	
American Mildew (*Sphaerotheca mors-uvae* (Schw.) Berk.)	General
European Mildew (*Microsphaera Grossulariae* (Wallr.) Lév.)	do.
Cluster Cup Rust (*Puccinia Pringsheimiana* Kleb.)	do.
Leaf Spot (*Pseudopeziza Ribis* Kleb.)	Common
Die Back (*Botrytis cinerea* Pers.)	On old bushes
Black Pustule (*Plowrightia ribesia* (Pers.) Sacc.)	do.
Hendersonia Grossulariae Oudem.	Edinburgh, Glasgow
BLACK CURRANT.	
Reversion (Virus disease)	General
American Mildew (*Sphaerotheca mors-uvae* (Schw.) Berk.)	Elgin, Perth, etc.
Leaf Spot (*Pseudopeziza Ribis* Kleb.)	General
Coral Spot (*Nectria cinnabarina* (Tode) Fr.)	Occasional
Die Back (*Botrytis cinerea* Pers.)	Forfar, Edinburgh, etc.
Fasciation	Not uncommon
RED CURRANT.	
Leaf Spot (*Pseudopeziza Ribis* Kleb.)	General
Coral Spot (*Nectria cinnabarina* (Tode) Fr.)	do.
Black Pustule (*Plowrightia ribesia* (Pers.) Sacc.)	On old bushes, Lothians, etc.
RASPBERRY.	
Canker (*Nectria Rubi* Osterw.)	Elgin, Perth
Rust (*Phragmidium Rubi-Idaei* (Pers.) Karst.)	General
Blue Stripe Wilt (*Verticillium Dahliae* Kleb.)	Berwick
Die-back (sudden, cause unknown)	Perth, Lanark, etc.
Mosaic (Virus disease)	Perth, etc.
LOGANBERRY.	
Cane Blight (*Leptosphaeria Coniothyrium* (Fkl.) Sacc.)	Midlothian
Anthracnose (*Plectodiscella veneta* Burkh. =*Gloeosporium venetum* Speg.)	do.
STRAWBERRY.	
Mildew (*Sphaerotheca Humuli* (DC.) Burr.)	General
Leaf Spot (*Mycosphaerella Fragariae* (Tul.) Lindau)	do.
Leaf Scorch (*Marssonina Fragariae* (Sacc.) Kleb.)	do.
Red Core (*Phytophthora* sp.)	Lanark, Aberdeen, Fife, etc.

GRAPE VINE.

	Locality
Powdery Mildew (*Uncinula necator* (Schw.) Burr.)	Glasshouses
Grey Mould (*Botrytis cinerea* Pers.)	do.
Scorch and Shelling (Physiological)	do.

MELON.

Damping-off (*Phytophthora* sp.)	Fife

BANANA (Imported).

Soft Rot (*Thielaviopsis paradoxa* (de Seyn.) v. Höhn.).

OLIVES (Stored).

Rot (*Monilia* sp. and *Oidium* sp.).

ORANGE (Imported).

Fruit Rot (*Alternaria citri* Pierce).

OTHER CITRUS sp.

Sooty Mould (*Capnodium* sp. and *Meliola* sp.).

FIG (Imported).

Smut (*Aspergillus Ficuum* (P. Henn.) Wehm.=*Sterigmatocystis ficuum* P. Henn.).

ROOTS.

SWEDES.

Finger and Toe (*Plasmodiophora Brassicae* Woron.)	General
White Blister (*Cystopus candidus* (Pers.) de Bary) (Rare).	Coldstream
Dry Rot (*Phoma Lingam* (Tode) Desm.)	Fairly general
Leaf Spot (*Gloeosporium concentricum* (Grev.) Berk. et Br.)	Occasional

BEET and SUGAR BEET.

Black Leg (*Phoma Betae* (Oud.) Frank)	Edinburgh, etc.
Rust (*Uromyces Betae* (Pers.) Tul.)	Aberdeen, etc.

PULSE.

FIELD and BROAD BEAN.

Chocolate Spot (*Bacillus Lathyri* Manns et Taub.)	Edinburgh
Rust (*Uromyces Fabae* (Pers.) de Bary).	Not often reported
Mosaic	do.

FRENCH BEAN.

Anthracnose (*Colletotrichum Lindemuthianum* (Sacc. et Magn.) Bri. et Cav.)	Occasional

PEAS.

Powdery Mildew (*Erysiphe Polygoni* DC.)	Distributed
Spot (*Ascochyta Pisi* Lib.)	General
Anthracnose (*Colletotrichum* sp.)	Edinburgh district
Stripe (*Pseudomonas seminum* Cayley)	Distributed
Root Rot (*Aphanomyces euteiches* Drechsl.)	Aberdeen, Fife, Glasgow
Root Rot (*Thielavia basicola* Zopf.). Doubtfully parasitic.	Occasional
Mosaic	Rare

VEGETABLES.

BRASSICAE (CABBAGE, CAULIFLOWER), etc.	*Locality*
Finger and Toe (*Plasmodiophora Brassicae* Woron.)	General
Downy Mildew (*Peronospora parasitica* (Pers.) Tul.)	do.
Powdery Mildew (*Erysiphe Polygoni* DC.)	Distributed
White Blister (*Cystopus candidus* (Pers.) de Bary)	Rare, do.
Damping-off (*Pythium* sp.)	General
Ring Spot (*Mycosphaerella brassicicola* (Fr.) Lindau)	Occasional
Leaf Spot (*Gloeosporium concentricum* (Grev.) Berk. et Br.)	do.
Heart Rot (Physiological, cause unknown)	Lothians
Black Rot (*Pseudomonas campestris* (Pamm.) E.F.S.)	West
White Rot (*Pseudomonas destructans* Pott.)	Occasional in the West

HORSE RADISH.	
White Blister (*Cystopus candidus* (Pers.) de Bary)	Aberdeen

CUCUMBER.	
Stem Rot (*Sclerotinia sclerotiorum* (Lib.) de Bary)	Edinburgh
Wilt (*Verticillium albo-atrum* Reinke et Berth.)	do.
Mildew (*Erysiphe Cichoracearum* DC.)	Aberdeen

VEGETABLE MARROW.	
Mildew (*Erysiphe Cichoracearum* DC.)	Common late in dry seasons, Aberdeen
Anthracnose (*Colletotrichum oligochaetum* Cav.)	do.

CELERY.	
Soft Rot (*Bacillus carotovorus* L. R. Jones)	Lothians
Leaf Spot (*Septoria Apii* Chester=*S. Petroselini* Desm. var. *Apii* Bri. et Cav.)	General

LETTUCE.	
Bacterial Spot (*Bacterium pyocyaneum* (Gessard) Lehm. et Neum.=*B. marginale* N. A. Brown)	Local
Downy Mildew (*Bremia Lactucae* Regel)	Rare, Lothians
Ring Spot (*Marssonina panattoniana* Berl.)	Common
Grey Mould (*Botrytis cinerea* Pers.)	Common in wet seasons

TOMATO.	
Damping-off and Foot Rot (*Phytophthora cryptogea* Peth. et Laff. and *P. parasitica* Dast.)	Common, Lanark
Buck-eye Rot (*Phytophthora parasitica* Dast.=*P. terrestris* Sherb.)	Occasional
Violet Root Rot (*Rhizoctonia violacea* Tul. and *R. Crocorum* (Pers.) DC.)	do.
Wilts (*Verticillium albo-atrum* (Reinke et Berth.) and *Fusarium* sp.)	Doubtful
Leaf Mould (*Cladosporium fulvum* Cooke)	General

	Locality
Grey Mould (*Botrytis cinerea* Pers.)	Occasional
Stripe (now considered a virus)	General
Fruit Rots (*Phoma destructiva* Plowr., *Macrosporium solani* E. et M., *Alternaria* sp., and *Stemphylium* sp.)	Occasional
Blossom End Rot (Physiological)	do.
Mosaic, Aucuba Mosaic, and Fern Leaf Mosaic	Fairly general

ONION.

Downy Mildew (*Peronospora Schleideni* Unger)	General
Neck Rot (*Botrytis Allii* Munn)	Rare
White Rot (*Sclerotium cepivorum* Berk.)	General
Smut (*Urocystis Cepulae* Frost)	Lothians

LEEK.

White Tip (*Phytophthora Porri* Foister)	Lothians
White Rot (*Sclerotium cepivorum* Berk.)	General
Rust (*Puccinia Porri* (Sow.) Wint.)	do.
Smut (*Urocystis Cepulae* Frost)	Lothians
Stripe (cause unknown, but Virus suspected)	do.

MINT.

Rust (*Puccinia Menthae* Pers.)	Common

RHUBARB.

Crown Rot (cause unknown, but *Pythium* sp. and *Bacterium* sp. associated)	General

POTATO.

Early Leaf Blight (*Macrosporium Solani* E. et M.=*Alternaria Solani* (E. et M.) Jones et Grout)	Edinburgh
Wilt (*Verticillium albo-atrum* Reinke et Berth.)	Very rare, do.
Black Dot (*Colletotrichum atramentarium* (Berk. et Br.) Taub.)	Rare, East Linton
Stalk Break (Stem Rot) (*Sclerotinia Sclerotiorum* (Lib.) de Bary)	Prevalent in the West

The following were usually reported to the Seed-testing Station:

Skin Spot (*Oospora pustulans* Owen et Wakef.).
Blight (*Phytophthora infestans* (Mont.) de Bary).
Common Scab (*Actinomyces scabies* (Thaxt.) Güssow).
Powdery Scab (*Spongospora subterranea* (Wallr.) Lagerh.).
Wart Disease (*Synchytrium endobioticum* (Schilb.) Perc.).
Dry Rot (*Fusarium caeruleum* (Lib.) Sacc.).
Blackleg (*Bacillus phytophthorus* Appel=*B. atrosepticus* van Hall).

FORAGE AND PASTURE CROPS.

CLOVER (WILD WHITE CLOVER).

Leaf Spot (*Pseudopeziza Trifolii* (Biv.-Bern.) Fckl.).	
Black Blotch (*Dothidella Trifolii* (Pers.) Bayl.-Ell. et Stans.) (*Polythrincium* stage)	Ayr, Lauder
Rust (*Uromyces flectens* Lagh.)	Edinburgh

	Locality
Red Clover.	
Mildew (*Erysiphe Polygoni* DC.)	Ayr, Lothians
Leaf Spot (*Pseudopeziza Trifolii* (Biv.-Bern.) Fckl.)	Ayr
Scorch (*Kabatiella caulivora* (Kirchn.) Karak.=*Gloeosporium caulivorum* Kirchn.)	Ayr, Lothians
Black Blotch (*Dothidella Trifolii* (Pers.) Bayl.-Ell. et Stans.) (*Polythrincium* stage).	
Alsike.	
Leaf Spot (*Pseudopeziza Trifolii* (Biv.-Bern.) Fckl.).	
Downy Mildew (*Peronospora Trifoliorum* de Bary)	Lothians, Ayr
Black Medick.	
Leaf Spot (*Pseudopeziza Trifolii* (Biv.-Bern.) Fckl.)	do., do.
Black Blotch (*Dothidella Trifolii* (Pers.) Bayl.-Ell. et Stans.) (*Polythrincium* stage)	do.
Cock's Foot.	
Rathay's Disease (*Aplanobacter Rathayi* E. F. Sm.)	Perthshire
Rye Grass.	
Ergot (*Claviceps purpurea* (Fr.) Tul.)	Ayr
Timothy Grass.	
Rust (*Puccinia Phlei-pratensis* Erikss. et Henn.)	do.

CEREALS.

(Investigations on Wheat were confined to the Lothians.)

Wheat.	
Mildew (*Erysiphe graminis* DC.).	
Mould (*Macrosporium* sp.).	
Whiteheads (*Ophiobolus graminis* Sacc.).	
Black Rust (*Puccinia graminis* Pers.).	
Yellow Rust (*Puccinia glumarum* (Schm.) Eriks. et Henn.).	
Oats.	
Black Rust (*Puccinia graminis* Pers.)	Dumfries and West
Crown Rust (*Puccinia Lolii* Niels.=*P. coronifera* Kleb.)	General
Loose Smut (*Ustilago Avenae* (Pers.) Jens.)	do.
Mildew (*Erysiphe graminis* DC.)	do.
Grey Spot (*Scolecotrichum graminis* Fckl.)	Ayr
Moulds (*Alternaria* sp. and *Cladosporium* sp.)	Lothians
Leaf Spot or Stripe (*Helminthosporium Avenae* (Bri. et Cav.) Eid.)	Midlothian and West
Take-All (*Ophiobolus graminis* Sacc.)	Lothians
Barley.	
Mildew (*Erysiphe graminis* DC.)	General
Net Blotch (*Pyrenophora teres* (Died.) Drechsl.=*Helminthosporium teres* Sacc.)	Midlothian

FLOWERS AND OTHER ORNAMENTAL PLANTS.

ANEMONE.

	Locality
Rust (*Puccinia Pruni-spinosae* Pers.)	Midlothian
Rust (*Ochrospora Sorbi* Diet. ?)	Edinburgh
Smut (*Urocystis anemones* (Pers.) Wint.).	

ANTIRRHINUM.

Wilt (*Sclerotinia Sclerotiorum* (Lib.) de Bary)	Dumfries
Foot Rot (*Pythium* sp. and *Phytophthora* sp.)	Aberdeen
Root Rot (*Rhizoctonia* sp.)	Occasional, Lothians
Stem Rot (*Phyllosticta Antirrhini* Syd.)	Edinburgh

ASTERS.

Wilt (*Phytophthora parasitica* Dastur and *P. cryptogea* Peth. et Laff.)	Glasshouse, Selkirk
Ramularia macrospora var. *asteris*	Edinburgh

BARBERRY.

Rust (*Puccinia graminis* Pers.)	Perth, Dumfries, and Lothians

BEGONIA.

Damping-off (*Pythium* sp. and *Phytophthora* sp.)	Edinburgh
Leaf Spots (*Gloeosporium Begoniae* Magna., and *Phyllosticta Begoniae* Brun.)	do.
Mosaic-like leaves (Physiological).	

BELLADONNA.

Wilt and Root Rot (*Phytophthora erythroseptica* Peth. var. *atropae* Alcock)	do.

BOG MYRTLE.

Leaf and Twig Blight (*Ovularia destructiva* (Phil. et Plow.) Mass.)	Garelochhead

BOX.

Rust (*Puccinia Buxi* DC.)	Dumfries

CALCEOLARIA.

Foot Rot (*Phytophthora* sp.)	Midlothian

CARNATION.

Leaf Rot (*Pseudodiscosia Dianthi* Höst. et Laub.)	Lothians
Rust (*Uromyces Dianthi* (Pers.) Niessl. = *U. Caryophyllinus* (Schrank) Schroet.)	do.
Mildew (*Oidium* sp.)	do.

CHRYSANTHEMUM.

Mildew (*Oidium Chrysanthemi* Rabenh.)	Edinburgh
Leaf Spot (*Phoma Chrysanthemi* Vogl.)	Lothians

	Locality
Crinum.	
Damping-off (*Botrytis* sp.).	
Dahlia.	
Black Blight (Fungus disease, not identified)	Lothians
Virus (suspected)	do.
Delphinium.	
Mildew (*Erysiphe Polygoni* (DC.) Salm.)	do.
Fuchsia.	
Damping-off (*Botrytis* sp.)	Glasshouses
Gladiolus.	
Dry Rot (*Sclerotium Gladioli* Mass.)	Lothians
Storage Rot (*Penicillium Gladioli* McCull. and Thom)	do.
Gloxinia.	
Wilt (*Phytophthora cryptogea* (Peth. et Laff.))	Glasshouses, do.
Hollyhock.	
Rust (*Puccinia Malvacearum* Mont.)	General
Hyacinth.	
Yellow Disease (*Bacterium Hyacinthi* Wakk.). (Imported bulbs.)	
A Soft Rot (Bacterial) (*Bacillus carotovorus* L. R. Jones, suspected—not identified)	Edinburgh
Hypericum Androsaemum.	
Rust (*Melampsora Hypericorum* Wint.)	Lothians
Iris.	
Leaf Rot (*Pseudomonas Iridis* van Hall)	Edinburgh
Rust (*Puccinia Iridis* (DC.) Wallr.)	do.
Bulb Rot (*Penicillium Gladioli* McCull. et Thom) (Storage Rot).	
Leaf Spot (*Heterosporium gracile* Sacc.)	do.
Lily.	
Lily Disease (*Botrytis elliptica* (Berk.) Cke.)	do.
Rosette, Yellow Flat or Bermuda Lily Disease (Virus)	do.
Mahonia.	
Rust (*Puccinia mirabilissima* (Peck))	The Borders, Fife, Peeblesshire, General in Lothians
Meconopsis sp.	
Mildew (*Peronospora arborescens* de Bary)	Edinburgh
Wilt (*Sclerotium* sp.)	do.

	Locality
Moschatel (*Adoxa moschatellina*).	
Rust (*Puccinia Adoxae* Hedw. f.)	Edinburgh
Narcissus.	
Smoulder (*Botrytis narcissicola* Kleb.)	do.
White Mould (*Ramularia Vallisumbrosae* Cav.)	do.
Pelargonium.	
Blackleg (*Pythium* sp.)	Borders
Grey Mould (*Botrytis cinerea* Pers.)	Common
White Spots and Mottling (Physiological).	
Petunia.	
Foot Rot (*Phytophthora cryptogea* Peth. et Laff.)	Edinburgh
Phlox.	
Damping-off (*Phytophthora parasitica* Dastur)	do.
Polypodium iroides.	
Leaf Spot (*Sphaerella aquilina* (Fr.) Awd.)	do.
Privet.	
Honey Agaric (*Armillaria mellea* (Vahl.) Fr.)	do.
Rhododendron.	
Gall (*Exobasidium Vaccinii* (Fckl.) Woron.)	Lothians, Ayr, etc.
Leaf Scorch (*Sporocybe Azaleae* (Peck) Sacc.)	Edinburgh
Stem Canker (*Botrytis* sp.)	Argyll
Sooty Mould (*Meliola* sp.)	Edinburgh
Rose.	
Black Spot (*Diplocarpon Rosae* Wolf=*Actinonema Rosae* (Lib.) Fr.)	General
Mildew (*Sphaerotheca pannosa* (Wallr.) Lév.)	do.
Rust (*Phragmidium mucronatum* (Pers.) Schlecht.=*P. disciflorum* James and *P. subcorticium* Wint.)	do.
Graft Canker (*Coniothyrium Rosarum* (Cke. et Harkn.))	Edinburgh
Scilla.	
Smut (*Ustilago Vaillantii* Tul.)	do.
Stock.	
Downy Mildew (*Peronospora parasitica* (Pers.) Tul.)	Lothians
Wilt (*Phytophthora cryptogea* Peth. et Laff.)	do.
Stem Rot (*Rhizoctonia Solani* Kühn)	do.

	Locality
Sweet Pea.	
Mildew (*Peronospora Viciae* (Berk.) de Bary)	Occasional
Streak (*Bacillus Lathyri* Manns. et Taub.)	General
Root Rot (*Aphanomyces euteiches* Drechsl.)	Aberdeen, Glasgow, Edinburgh
Leaf Spot (*Ascochyta Pisi* Lib.)	Edinburgh
Tulip.	
Shanking (*Phytophthora cryptogea* Peth. et Laff.)	Ayr, Lothians
Fire (*Botrytis Tulipae* (Lib.) Lind.)	General
Grey Bulb Rot (*Rhizoctonia Tuliparum* (Kleb.) Whetz. et Arth.=*Sclerotium Tuliparum* Kleb.)	Edinburgh
Rust (*Puccinia Prostii* Mong.)	do.
Storage Rot (*Penicillium* sp.).	
Glenmoriston Disease (*Cercosporella* sp.)	Inverness
Veronica Chamaedrys.	
Root Gall (*Sorosphaera Veronicae* Schroet.)	Aberdeen
Viola.	
Root Rot (*Aphanomyces* sp.)	Lothians
Rust (*Puccinia aegra* Grove)	Edinburgh
Mildew (*Oidium* sp.)	Lothians
Dry Rot (*Phoma violae-tricoloris* (Died.))	do.
Wallflower.	
Finger and Toe (*Plasmodiophora Brassicae* Woron.)	Edinburgh
Downy Mildew (*Peronospora parasitica* (Pers.) Tul.)	General
Damping-off (*Pythium* sp.)	Fife
Zinnia.	
Foot Rot (*Phytophthora cryptogea* Peth. et Laff.)	Lothians

CONIFERS.

Abies pectinata.	
Die Back (*Rehmiellopsis bohemica* Bub. et Kab.)	West of Scotland, Forres
Witches' Broom (*Melampsorella caryophyllacearum* Schroet.)	Distributed
Douglas Fir.	
Leaf Cast (*Rhabdocline Pseudotsugae* Sydow)	Borders
Scots Pine.	
Canker (*Dasyscypha* sp.)	St. Andrews
Leaf Cast (*Lophodermium pinastri* (Schr.) Chev.)	General
Spruce.	
Rust (*Chrysomyxa abietis* Unger)	Selkirk

	Locality
THUJA PLICATA.	
Keithia thujina Durand	Distributed
YEW.	
Leaf Scorch (*Sphaerulina Taxi* Mass.)	do.

BROAD-LEAVED TREES.

ASH.	
Canker (*Nectria galligena* Bres.)	Fife (distributed)
Bacterial Canker	Fife and Borders
BEECH.	
Canker (*Nectria coccinea* (Pers.) Fr.)	Distributed
HAWTHORN.	
Mildew (*Podosphaera Oxyacanthae* (DC.) de Bary)	General
LABURNUM.	
Branch Canker (*Calonectria Pseudopeziza* (Desm.) Sacc.)	Edinburgh
Cucurbitaria Laburni de Not.	Lothians
LILAC.	
Wilt (*Phytophthora Syringae* Kleb.)	Edinburgh
POPLAR.	
Leaf Curl (*Taphrina aurea* Sade.)	General
Rust (*Melampsora Larici-populina* Lév.)	do.
Brown Slime Flux (*Bacteria*)	Fifeshire (common)
ROWAN.	
Silver Leaf (*Stereum purpureum* Pers.)	Edinburgh
SYCAMORE.	
Scorch (*Gnomonia veneta* (Sacc. et Speg.) Kleb.)	Kirkcaldy
Tar Spot (*Rhytisma acerinum* (Pers.) Fr.)	Common
WILLOW.	
Scab (*Fusicladium saliciperdum* (All. et Tub.))	Beauly
Stem Blister (*Cryptomyces maximus* (Fr.) Rehm.)	do.
Branch Disease (*Scleroderris fuliginosa* Karst.)	do.
„ „ (*Myxosporium scutellatum* Otth. (Petrak))	do.

MISCELLANEOUS.

	Locality
HEATHER.	
Honey Agaric (*Armillaria mellea* (Vahl.) Fr.)	Arran
HOP (Wild).	
Mildew (*Sphaerotheca Humuli* (DC.) Burr.)	Dumfries
TOBACCO (Imported).	
Mould (*Botrytis longibrachiata* Oud.).	
Mildew (*Peronospora Nicotianae* Speg.).	
TURF.	
Brown Patch (*Corticium fusiforme* (Berk.) Wakef.	On golf and other greens, Lothians
Puff Ball (*Bovista plumbea* Pers.)	On golf greens

OBITUARY NOTICE.

William Carmichael M'Intosh.
1838–1931.

Natural Science lost one of its noblest exponents with the death of Professor William Carmichael M'Intosh on 1st April 1931. Dr. M'Intosh, as he then was, joined the Botanical Society of Edinburgh in 1880, two years before he was called to the Chair of Natural History in his Alma Mater, St. Andrews.

Previously he was Medical Superintendent of Murthly Institution, and the beauty of the Perthshire estates which surrounded the Institution influenced his choice and development of Neeve Park, his summer residence in later years. Though pre-eminently a marine zoologist, Professor M'Intosh maintained throughout his life his interest in plants.

Accounts of his contributions to Natural Science, and the many distinctions which accrued to him through their publication, have appeared elsewhere. Of all the honours he received none was appreciated more highly by himself than the award of the Linnean Gold Medal in 1924.

A student first of St. Andrews University, Professor M'Intosh graduated in Medicine at Edinburgh University. It is at the former University that his name is remembered with gratitude for the great interest he took in the welfare of the students. He held not only the respect and admiration but also the affection of all who knew him.

To the end, in his ninety-third year, he retained his mental faculties unimpaired, and up to the last was a keen research student. He was a strenuous worker, regulating his labours by time-table. In consequence of this in his leisure he found time to help others, and it was only last winter that he contributed personal notes on past presidents of the Botanical Society, which it is intended to utilise at the centenary of the Society of which for over fifty years he was a loyal member.

R. J. D. Graham.

ROLL

OF

THE BOTANICAL SOCIETY OF EDINBURGH.

Corrected to September 1931.

Patron:

HIS MOST GRACIOUS MAJESTY THE KING.

HONORARY FELLOWS.

BRITISH SUBJECTS (LIMITED TO SIX).

Date of Election.	
June 1923.	Druce, G. Claridge, M.A., LL.D., F.R.S., 9 *Crick Road, Oxford.*
Dec. 1907.	Farmer, Sir John Bretland, M.A., D.Sc., F.R.S., *Professor of Botany, Imperial College of Science and Technology, S. Kensington.*
Dec 1930.	Lang, William Henry, M.B., C.M., D.Sc., F.R.S., *Barker Professor of Cryptogamic Botany, University of Manchester.*
June 1923.	Praeger, R. Lloyd, B.A., D.Sc., *National Library of Ireland, Kildare Street, Dublin.*
June 1923.	Rendle, A. B., M.A., D.Sc., F.R.S., "*Talland,*" *The Mount, Fetcham Park, Leatherhead, Surrey.*
Feb. 1912.	Scott, D. H., M.A., LL.D., Ph.D., F.R.S., *East Oakley House, Basingstoke, Hants.*

FOREIGN (LIMITED TO TWENTY-FIVE).

June 1902.	Britton, Nathaniel Lord, *care of the Botanic Garden, New York.*
June 1923.	Campbell, Dr. Douglas Houghton, *Professor of Botany, Stanford University, California;—Corresponding Member, Dec.* 1905.
June 1923.	Chodat, Professor Dr. Robert, *L'Université, Geneva.*
Feb. 1911.	Flahault, Dr. Charles, *Professor of Botany to the Faculty of Science, and Director of the Institute of the University, Montpellier.*
June 1923.	Ikeno, Professor Seittsiro, Ph.D., *Agricultural College, Imperial University, Tokio.*
June 1923.	Lecomte, Professor Henri, *Muséum d'Histoire Naturelle, Paris.*
June 1923.	Lotsy, Dr. J. P., *Spaarne* 17, *Haarlem.*
June 1923.	MacDougal, Dr. D. T., *Director of Department of Botanical Research, Carnegie Institution, Tucson.*

Date of Election.	
June 1923.	Osterhout, W. J. V., Ph.D., *Rockefeller Institute, 66th Street and Avenue A., New York.*
June 1923.	Thaxter, Professor Roland, Ph.D., 7 *Scott Street, Cambridge, Mass.*
June 1902.	Trelease, Dr. William, *University of Illinois, Urbana, Illinois, U.S.A.*
Mar. 1895.	Vries, Dr. H. de, *Professor of Botany in the University, Amsterdam.*

ORDINARY FELLOWS.

No distinguishing mark is placed before the name of Fellows who contribute annually and receive Publications.

* *Indicates Fellows who have compounded for Annual Contribution and receive Publications.*

† *Indicates Non-Resident Fellows who have compounded for Publications.*

‡ *Indicates Non-Resident Fellows who do not receive Publications.*

Date of Election.	
Dec. 1915.	Adam, Robert Moyes, 17 *W. Brighton Crescent, Portobello.*
Feb. 1905.	†Aiken, Rev. J. J. Marshall Lang, B.D., *The Manse, Ayton, Berwickshire.*
Jan. 1924.	Aitken, Mrs. W., 2 *Sycamore Terrace, Corstorphine.*
Nov. 1924.	*Alcock, Mrs. N. L., F.L.S., 14 *Inverleith Row, Edinburgh.*
Feb. 1931.	Allardyce, G. L., W.S., 25 *Rutland Street, Edinburgh.*
Feb. 1925.	Anderson, J. B., 76 *South Trinity Road, Edinburgh.*
Nov. 1926.	*Anthony, John, M.C., M.A., B.Sc., 7 *Craigcrook Gardens, Edinburgh.*
Dec. 1924.	Armstrong, D., *The Drum, Gilmerton, Midlothian.*
Dec. 1908.	‡Balfour, F. R. S., M.A., 39 *Phillimore Gardens, Kensington, London, W.*
May 1891.	*Berwick, Thomas, 56 *North Street, St. Andrews.*
Feb. 1919.	†Blackburne, Cecil Ireland, *Ashurst, Fernhurst, near Haslemere, Surrey.*
April 1926.	Blackie, John Joseph, Ph.C., 104 *Holyrood Road, Edinburgh.*
May 1888.	*Bonnar, William, 51 *Braid Avenue, Edinburgh.*
Jan. 1899.	*Borthwick, A. W., O.B.E., D.Sc., *Professor of Forestry, The University, Aberdeen.*
Dec. 1886.	*Bower, F. O., M.A., D.Sc., F.R.S., F.L.S., 2 *The Crescent, Ripon.*
Mar. 1927.	Boyd, Miss Lucy, D.Sc., 3 *West Brighton Crescent, Portobello.*
April 1913.	‡Brebner, James, 2 *Scotswood Terrace, Dundee.*
Feb. 1928.	Brodie, John A., 16 *Montagu Terrace, Edinburgh.*
Nov. 1929.	Brown, Alex. B., B.Sc., *Dept. of Botany, University of Alberta, Edmonton, Canada.*
May 1924.	†Brown, Miss Helen M., *Longformacus, Duns.*
Dec. 1906.	†Bryce, George, D.Sc., *Dept. of Agriculture, Ibadan, Nigeria.*
Nov. 1922.	Buchanan, E. M., 76 *Warrender Park Road, Edinburgh.*
Dec. 1921.	‡Burns, W., D.Sc., *Bombay Agric. Dept., Poona, Bombay, India.*
Oct. 1928.	Burrell, Sir William, *Hutton Castle, Berwick-on-Tweed.*
Dec. 1924.	†Burt, Miss C. C., B.Sc., 36 *Ravenshaugh Road, Levenhall, Musselburgh.*
Dec. 1915.	Cadman, Miss Elsie, M.A., B.Sc., Ph.D., *College of Agriculture,* 13 *George Square, Edinburgh.*
Oct. 1926.	*Callender, Wm. C., *Georgefield,* 31 *Inverleith Terrace, Edinburgh.*
April 1926.	Cardross, The Rt. Hon. Lord, *Almondell House, Mid-Calder.*
Dec. 1928.	Clarke, Robert R., B.Sc., *Whitehall, Aberdour, Fife.*
April 1913.	Cooper, R. E., *Royal Botanic Garden, Edinburgh.*
Mar. 1900.	*Cowan, Alexander, *Valleyfield, Penicuik.*
Oct. 1930.	Cowan, John M., M.A., D.Sc., 17 *Inverleith Place, Edinburgh.*
June 1929.	Cowan, Robert Craig, *Eskhill, Musselburgh.*
Feb. 1923.	†Cox, E. H. M., 32 *Old Bond Street, London, W.* 1.
Dec. 1915.	*Craib, W. G., M.A., *Professor of Botany, Aberdeen.*
Jan. 1922.	*Dales, Mrs. H., M.A., B.Sc., *Allora, Kensington Gardens, Knock, Belfast.*
Oct. 1926.	Davey, V. E. M., B.Sc., Ph.D., *Plant Breeding Station, Corstorphine.*
Dec. 1903.	Davidson, J. Randolph, M.A., B.Sc., 49 *Meadway Court, Golders Green, London, N.W.* 11.
Dec. 1911.	‡Davidson, John, *Assistant Professor of Botany, University of British Columbia, Vancouver. Canada.*

Date of Election.	
Dec. 1892.	Day, T. Cuthbert, F.I.C., 36 *Hillside Crescent, Edinburgh.*
Nov. 1925.	De Pree, Mrs., *Beach Hill, Haddington.*
Dec. 1930.	Dickson, Miss A. M., *Woodhouse, Dunscore, Dumfriesshire.*
Nov. 1927.	*Dobson, Miss Margaret Gairns, 8 *Polwarth Terrace, Edinburgh.*
Nov. 1919.	*Downie, Miss D. G., B.Sc., 1 *W. Stanhope Place, Edinburgh.*
May 1921.	Drummond, J. Montagu F., M.A., F.L.S., *Harrison Professor of Botany, University of Manchester.*
Feb. 1931.	Egerton, Major-General Granville, 7 *Inverleith Place, Edinburgh.*
Feb. 1917.	†Eley, Charles, *East Bergholt Place, Suffolk.*
Nov. 1885.	Elliot, G. F. Scott, M.A., B.Sc., *Howpathay, Cowday Wood, Wadhurst, Sussex.*
Jan. 1883.	*Evans, Arthur H., Sc.D., *Cheviot House, Crowthorne, Berks.*
Dec. 1905.	*Evans, W. Edgar, B.Sc., 38 *Morningside Park, Edinburgh.*
Dec. 1927.	Fenton, E. Wyllie, M.A., B.Sc., F.L.S., F.E.S., 16 *Wilton Road, Edinburgh.*
Oct. 1928.	Foister, Charles Edward, B.A., Ph.D., c/o Hodgkinson, 15 *Goldenacre Terrace, Edinburgh.*
Feb. 1928.	Forrest, Mrs. George, *Bellfield, Bonnyrigg Road, Eskbank, Midlothian.*
Feb. 1931.	Fortune, T. A. S., *Cairngreen, Davidson's Mains, Edinburgh.*
Jan. 1906.	*Fraser, James, 18 *Park Road, Leith.*
Oct. 1920.	*Galloway, R. Angus, M.C., B.Sc., 81 *Cluny Gardens, Edinburgh.*
Dec. 1920.	†Garriock, John, M.A., B.Sc., *Morgan Academy, Dundee.*
May 1903.	‡Gilmore, Dr. Owen, L.R.C.P., L.R.C.S.E., 49 *Acre Lane, Brixton, London, S.W. 2.*
Dec. 1907.	Gourlay, Dr. W. Balfour, M.C., 7 *Millington Road, Cambridge.*
Nov. 1921.	*Graham, R. J. D., M.A., D.Sc., 45 *Stirling Road, Edinburgh.*
Mar. 1923.	Gray, John H., M.A., B.Sc., 28 *W. Relugas Road, Edinburgh.*
Jan. 1926.	Gregor, James W., Ph.D., F.L.S., *Craig's House, Corstorphine.*
Mar. 1925.	*Grieve, Miss Jean E., 11 *Lauder Road, Edinburgh.*
Dec. 1895.	*Grieve, Sommerville, 21 *Queen's Crescent, Edinburgh.*
Feb. 1879.	*Grieve, Symington, 11 *Lauder Road, Edinburgh.*
Nov. 1914.	†Harley, Andrew, *Blinkbonny, Kirkcaldy.*
Dec. 1923.	†Harris, Mrs. K., B.Sc., *Hazeldene, Stretten Avenue, Cambridge.*
April 1910.	Harvey, Miss Elsie, *Kerala, Captains Road, Liberton, Edinburgh.*
Mar. 1913.	†Hayward, Miss Ida M., F.L.S., 7 *Abbotsford Road, Galashiels.*
Dec. 1929.	Heddle, R. G., M.A., B.Sc., 13 *George Square, Edinburgh.*
May 1924.	‡Henderson, George, B.Sc., *Keith Grammar School, Keith, Banffshire.*
April 1886.	Hill, J. Rutherford, Ph.C., *Secretary, Pharmaceutical Society,* 36 *York Place, Edinburgh.*
Oct. 1926.	†Home, Miss Logan, *Edrom House, Edrom, Berwickshire.*
June 1927.	†Hornel, E. A., *Broughton House, Kirkcudbright.*
Mar. 1920.	Howison, Andrew, M.A., B.Sc., 18 *Beresford Avenue, Leith.*
May 1925.	Im Thurn, Sir Everard, K.C.M.G., K.B.E., *Cockenzie House, Prestonpans.*
Dec. 1907.	*Jeffrey, J. Frederick, *Laneside, Shipham, Winscombe, Somerset.*
Oct. 1925.	Johnston, Miss, *Aros, Colinton.*
May 1877.	*Johnston, Henry Halcro, C.B., C.B.E., D.Sc., M.D., F.L.S., *Colonel R.A.M.C., Mackay's Hotel, Stromness, Orkney.*
Dec. 1912.	*Johnstone, James Todd, M.A., B.Sc., *Royal Botanic Garden, Edinburgh.*
Mar. 1925.	Kean, Miss C. I., B.Sc., Ph.D., *Botanical Dept., University of St. Andrews.*
Jan. 1913.	*Kemp, Mrs. C. Norman, M.A., D.Sc., *Ivy Lodge, Laverockbank Road, Leith.*
Nov. 1924.	*King, Miss C. A., *Osborne Nursery, Corstorphine Road, Edinburgh.*
Oct. 1921.	King, Miss Isabella M., B.Sc., 4 *Cambridge Gardens, Edinburgh.*
Jan. 1924.	*Knox, Mrs. J., M.A., B.Sc., 43 *Dalhousie Terrace, Edinburgh.*
Nov. 1921.	*Laing, Ernest V., M.A., D.Sc., 13 *Belvedere Street, Aberdeen.*
Dec. 1911.	*Lamont, Miss Augusta, 73 *Falcon Road, Edinburgh.*
Nov. 1927.	Lang, J. M. S., B.S.A., *Craig's House, Corstorphine.*
May 1931.	Latham, H. A., 27 *Oxgangs Road, Lothianburn, Edinburgh.*
Dec. 1917.	Law, Mrs. John, 41 *Heriot Row, Edinburgh.*
Dec. 1922.	*Lewis, Herbert M., B.Sc., *Penucha, Caerwys, N. Wales.*
Oct. 1925.	†Low, Wm., *Balmakewan, Marykirk, Montrose.*
Nov. 1922.	‡M'Call, David, B.Sc., Ph.D., *Dundee Technical College, Bell Street, Dundee.*
Feb. 1925.	Macdonald, James, B.Sc., 25 *Drumsheugh Gardens, Edinburgh.*

Date of Election.	
Jan. 1895.	MacDougall, R. Stewart, M.A., D.Sc., *Ivy Lodge, Gullane, East Lothian.*
Jan. 1881.	†Macfarlane, John M., Sc.D., LL.D., F.R.S.E., *Emeritus-Professor of Botany, 427 West Hansberry Street, Germantown, Pa., U.S.A.*
Feb. 1886.	M'Glashan, D., *Kingscroft, Cramond Bridge.*
Dec. 1925.	*M'Intosh, A. E. S., B.Sc., Ph.D., *Assistant Geneticist, Dept. of Science and Agriculture, Barbados, B.W.I.*
Dec. 1925.	Mackie, Miss A. W., 11 *Bellevue Terrace, Edinburgh.*
June 1897.	†Macvicar, Symers M., *Invermoidart, Acharacle, Argyllshire.*
Feb. 1914.	Macwatt, John, M.B., C.M., *Morelands, Duns.*
Dec. 1896.	‡Mahalanobis, Professor S. C., B.Sc., F.R.S.E., P. 45, *New Park Street, Calcutta.*
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Oct. 1914.	*Martin, Miss Isa, M.A., *Hillview, Aberdour Road, Dunfermline.*
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April 1919.	‡Mills, A. E., 37 *High Street, Keynsham, near Bristol.*
Dec. 1930.	Muirhead, Charles, 32 *Inverleith Place, Edinburgh.*
Nov. 1929.	Murray, Miss F. B., M.A., *Royal Botanic Garden, Edinburgh.*
Oct. 1918.	†Murray, J. M., B.Sc., 25 *Drumsheugh Gardens, Edinburgh.*
Oct. 1930.	Murray, Robert., F.F.S., 11 *Murrayfield Gardens, Edinburgh.*
Dec. 1923.	*Nelson, Alex., B.Sc., Ph.D., *Royal Botanic Garden, Edinburgh.*
April 1916.	†Nicholson, C., F.E.S., "*Nansgwithick,*" *Tresillian, Probus, Cornwall.*
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Dec. 1907.	*Orr, Matt. Y., *Royal Botanic Garden, Edinburgh.*
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June 1891.	†Prain, Sir David, M.D., C.I.E., F.R.SS.L. & E., F.L.S., *The Well Farm, Warlingham, Surrey.*
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April 1877.	‡Riddell, Wm. R., B.A., B.Sc. (Hon. Mr. Justice), *Osgoode Hall, Toronto, Canada.*
Feb. 1926.	Robb, William, N.D.A., *Craig's House, Corstorphine.*
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Mar. 1902.	Sampson, Hugh C., C.I.E., B.Sc., *Royal Botanic Gdns., Kew, Surrey.*
May 1926.	‡Sangster, Mrs. Iris, *Fullerswood Park, Mountain Side P.O., Jamaica.*
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Dec. 1922.	Seaton, Ian W., B.Sc., *Plant Breeding Station, Stormount, Strandtown, Belfast.*
June 1922.	†Simpson, J. R., 15 *Highfield Crescent, Baildon, Yorks.*
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Oct. 1930.	Steel, William B., *Astley-Ainslie Institution, Grange Loan, Edinburgh.*
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Dec. 1923.	Steven, H. M., B.Sc., Ph.D., 20 *Alderman's Drive, Peterborough.*
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Oct. 1914.	†Stewart, Edward J. A., M.A., B.Sc., 8 *Manor Road, Jordanhill, Glasgow.*

Date of Election.	
April 1921.	Sutherland, John, C.B.E., LL.D., 11 *Inverleith Row, Edinburgh.*
May 1928.	Sutherland, Mrs. Kate, 11 *Inverleith Row, Edinburgh.*
Feb. 1902.	Tagg, Harry F., F.L.S., *Royal Botanic Garden, Edinburgh.*
Jan. 1913.	‡Tagg, M. H., 53 *Clayton Avenue, Wembley, Middlesex.*
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Oct. 1928.	Thomson, Miss Norah M'Nab, 30 *Drumsheugh Gardens, Edinburgh.*
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Nov. 1921.	*Watt, Miss Janet, 2 *W. Catherine Place, Edinburgh.*
Dec. 1930.	Whyte, James H., B.Sc., *Botany Dept., M'Gill University, Montreal, Canada.*
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Feb. 1912.	*Wilson, Malcolm, D.Sc., *Brentknoll, Kinnear Road, Edinburgh.*
Mar. 1909.	*Wilson, Thos., Ph.C., 110 *High Street, Burntisland.*
Jan. 1903.	Young, William, *Fairview, Kirkcaldy.*
Jan. 1923.	*Younger, Harry Geo., *Kittoes, Bishopsteignton, S. Devon.*

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Nov. 1930.	Cowan, Mrs., 17 *Inverleith Place, Edinburgh.*
Nov. 1926.	Drysdale, Miss D., *Royal Botanic Garden, Edinburgh.*
Nov. 1927.	Evans, Miss, 38 *Morningside Park, Edinburgh.*
Feb. 1928.	Forrest, John Eric, *Bellfield, Bonnyrigg Road, Eskbank, Midlothian.*
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Nov. 1930.	Gray, Miss Effie R., 13 *Leopold Place, Edinburgh.*
Nov. 1922.	Gregor, Mrs. Mary J. F., B.Sc., Ph.D., *North Clermiston House, Cramond Bridge, West Lothian.*
April 1925.	Knott, Eric, 21 *Stevenson Road, Edinburgh.*
Feb. 1930.	Lamb, Ivan M., 2 *Abercorn Avenue, Willowbrae, Edinburgh.*
Feb. 1931.	Macdonald, Jas. A., B.Sc., *Cowan House, George Square, Edinburgh.*
April 1925.	M'Ilvenna, Wm. R., 8 *Inverleith Terrace, Edinburgh.*
Nov. 1926.	Maclachlan, Miss C. M., B.Sc., 13 *South Gray Street, Edinburgh.*
Nov. 1928.	Maclagan, Miss J. F. A., B.Sc., c/o Strong, 7 *Gilmore Place, Edinburgh.*
Nov. 1930.	M'Martin, A., B.Sc., 24 *Buccleuch Place, Edinburgh.*
Nov. 1928.	Murray, John, *Whitslade, Broughton, Peeblesshire.*
Feb. 1928.	Pearson, Miss Peggy, *Otterburn, Kelso.*
Nov. 1930.	Petrie, Miss M. S., *Peffermill Cottage, Craigmillar, Edinburgh.*
Nov. 1930.	Pierce, F., c/o M'Murtrie, 20 *Lauriston Gardens, Edinburgh.*
Nov. 1926.	Redman, Miss A. W. H., B.Sc., 30 *Lomond Road, Leith.*
April 1925.	Robertson, Frederick W., 23 *Inverleith Place, Edinburgh.*
April 1927.	Robertson, J. R., 30 *Mayfield Terrace, Edinburgh.*
April 1925.	Robertson, Mrs. Marjory F., 23 *Inverleith Place, Edinburgh.*
April 1930.	Robson, Thomas, 6 *Kirkhill Road, Edinburgh.*
Nov. 1922.	Seaton, Mrs., *Plant Breeding Station, Belfast.*
Nov. 1930.	Smart, J. B., 4 *Chalmers Crescent, Edinburgh.*

Date of Election.	
Nov. 1926.	Smith, Miss M. H., B.Sc., *Inverleith House, Edinburgh.*
April 1925.	Smith, Thomas Arthur, 39 *Restalrig Road, Leith.*
Oct. 1927.	Stevenson, Miss J. J., 81 *Trinity Road, Edinburgh.*
April 1929.	Thomsen, Charles, 9 *Denham Green Terrace, Edinburgh.*
Dec. 1923.	Wallace, G. B., B.Sc., Ph.D., 9 *Graham Street, Edinburgh.*
Dec. 1929.	Weber, H. A., 1 *Eyre Place, Edinburgh.*
June 1928.	Williams, Prof. Basil, M.A., 34 *Drummond Place, Edinburgh.*
June 1928.	Williams, Mrs. Dorothy, 34 *Drummond Place, Edinburgh.*

ASSOCIATES.

Oct. 1927.	Forrest, George, V.M.H., *Bellfield, Bonnyrigg Road, Eskbank, Midlothian.*
Jan. 1906.	Harrow, R. L., Director, *Royal Horticultural Society's Gardens, Wisley, Ripley, Surrey.*
Feb. 1919.	Johnson, Norman M., B.Sc., *Ardgarth, Victoria Terrace, Dunfermline.*
Jan. 1906.	Stewart, L. B., *Royal Botanic Garden, Edinburgh.*

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June 1893.	Aitken, Mrs. A. P., 15 *Victoria Mansions, West Hampstead, London, N.W.*
April 1893.	Balfour, Lady Bayley, *Penfold's Corner, Haslemere, Surrey.*
Dec. 1926.	Callender, Mrs. C. A., 31 *Inverleith Terrace, Edinburgh.*
Feb. 1910.	Galletly, Mrs. Sarah H., 32 *Mansionhouse Road, Edinburgh.*
April 1902.	Grieve, Mrs. Symington, 11 *Lauder Road, Edinburgh.*
Nov. 1926.	Smith, Mrs., *Inverleith House, Edinburgh.*

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Dec. 1905.	Cockayne, L., Ph.D., F.R.S., F.L.S., *Ngaio, Wellington, New Zealand.*
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Mar. 1895.	Elfving, Dr. Fredrik, *Professor-Emeritus of Botany, Köpmansgatan* 10, *Helsingfors, Finland.*
Dec. 1905.	Gravis, Auguste, *Professor at the University, and Director of the Botanic Garden, Liége, Belgium.*
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Dec. 1905.	Miyabe, Dr. Kingo, *Professor of Botany, Hokkaido Imperial University, and Director of the Botanic Garden, Sapporo, Hokkaido, Japan.*
June 1902.	Miyoshi, Manabu, *Professor of Botany, Imperial University, Tokio, Japan.*
June 1902.	Raunkiaer, Professor Christen, *Botanic Museum, Copenhagen, Denmark.*
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Dec. 1905.	Schröter, Dr. Carl, *Professor of Botany and Director of the Botanical Museum, Zürich, Switzerland.*

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Czechoslovakia.

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Prague,	Czechoslovakian Botanical Society. The Botanical Institute, Charles University.

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Disko, Greenland,	Den Danske Arktiske Station.
Lyngby,	Statens plantepatologiske Forsög.

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LUXEMBOURG.

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	Botanic Garden.
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Tiflis,	Botanic Garden.

SWEDEN.

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Kurashiki,	Ohara Institute for Agricultural Research.
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Tokio,	College of Agriculture, Imperial University.

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	Linnean Society of New South Wales.
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South America.

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Rio de Janeiro,	Botanic Garden.
	Museu Naçional.
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	Society of Natural History.
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Columbus, O.,	Ohio State University.
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